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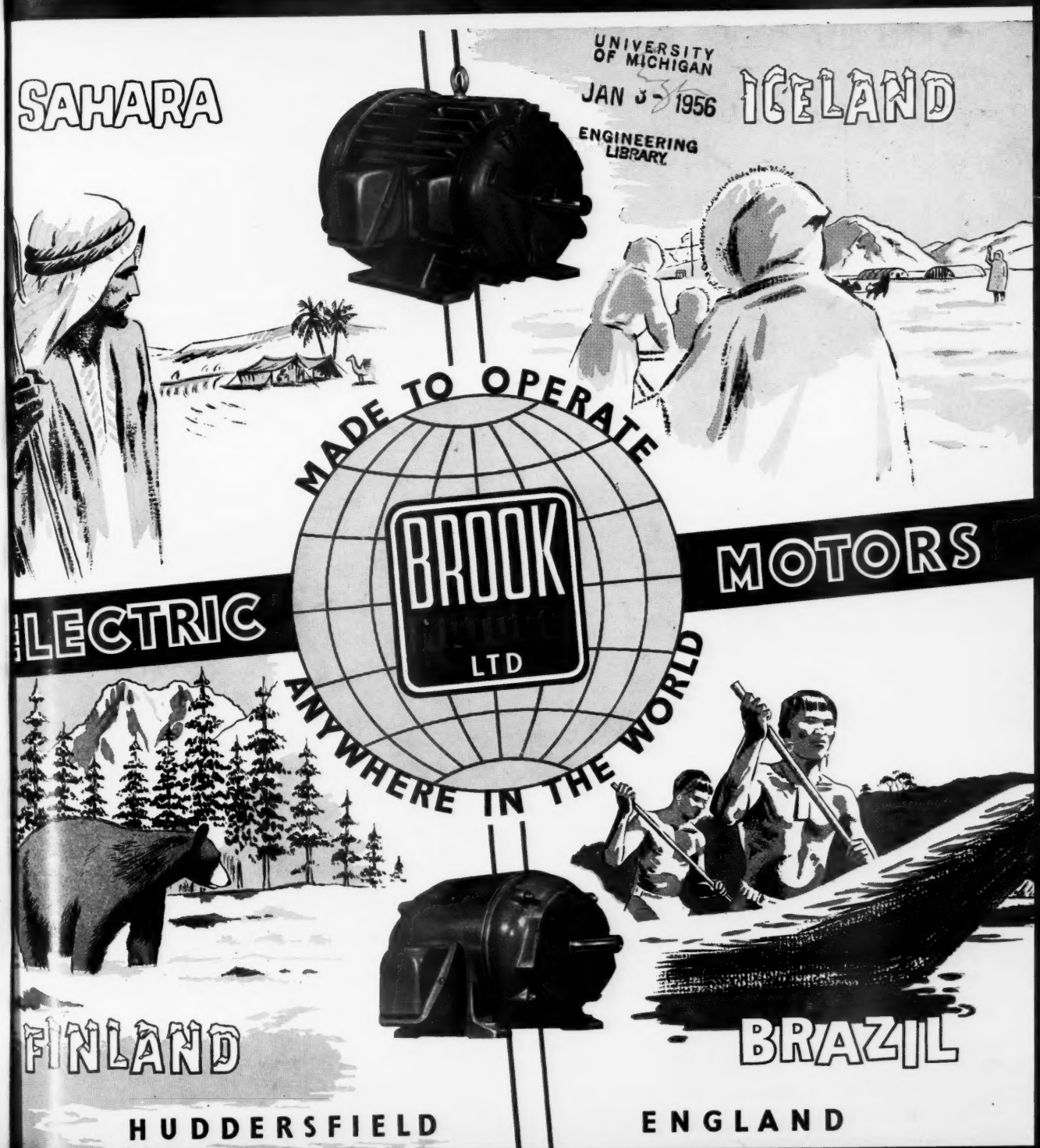

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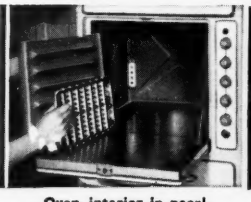

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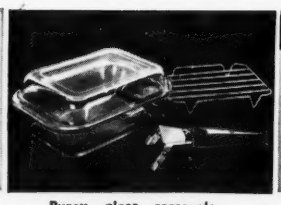

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ELECTRICAL REVIEW

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9 DECEMBER 1955

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VOLUME 157 ◇ NUMBER 24

Eighty-Fourth Year of Publication

FRIDAY ◇ PRICE 1s 6d

Editorial, Advertising and Publishing Offices: Dorset House, Stamford Street, London, S.E.1. Telegraphic Address: "Elecrev, Sedist, London." Code: ABC. Telephone No. Waterloo 3333 (60 lines). Registered at the General Post Office as a Newspaper. Entered as Second Class Matter at the New York, U.S.A., Post Office. Annual Subscription: Home and Overseas £4 10s 0d: U.S.A. and Canada $14.00. Cheques and Postal Orders (on Chief Office, London) payable to ELECTRICAL REVIEW PUBLICATIONS LTD., and crossed "Lloyds Bank."

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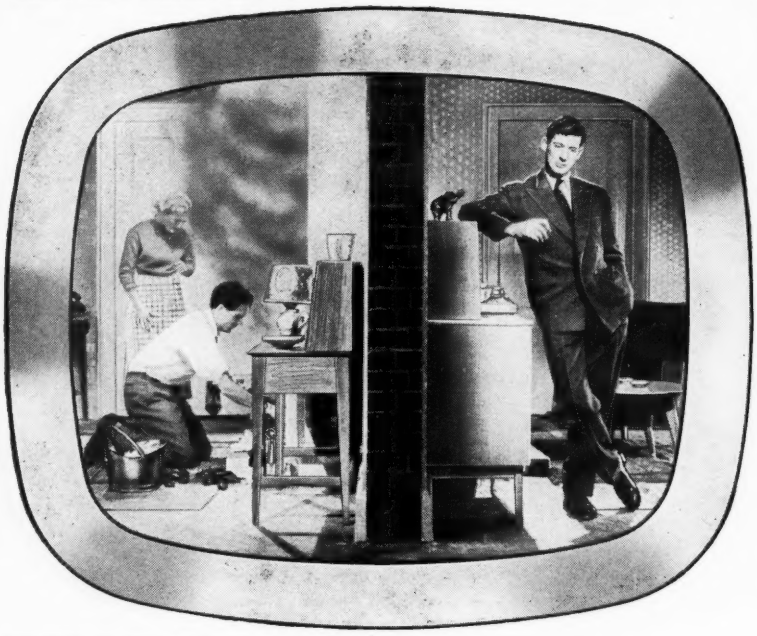

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ELECTRICAL REVIEW

9 December 1955 Vol. 157 No. 24 Established 1872

Nuclear Energy and Electricity

WE regard the inaugural meeting of the British Nuclear Energy Conference, which is reported elsewhere in this issue, as the first occasion on which the electrical industry has really got to grips with the nuclear energy power problem on the platform. The meeting was an outstanding success electrically, largely by reason of the high quality of the paper presented by Mr. V. A. Pask and Mr. J. C. Duckworth, chief engineer and nuclear power engineer, respectively, of the Central Electricity Authority, and of the discussion it provoked, following the lucid background picture given by Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell.

A note of confidence ran right through the papers and discussions from the opening address by Sir Christopher Hinton, managing director, Industrial Group, U.K.A.E.A.—confidence in our ability to generate electricity commercially from nuclear energy, confidence in being able to fill the gap between dwindling coal supplies and future energy demands in time, and confidence in being able to satisfy the public on the question of safety in running nuclear power equipment.

This high note of confidence was, however, tempered here and there by some serious doubts and warnings from authoritative speakers. Mr. J. Eccles, deputy chairman (operation) of the C.E.A., doubted whether the nuclear stations said to be required could be built in time, although Sir Claude Gibb insisted that the requirements could and must be met.

In view of the grave necessity to this country of securing another source of energy and the great hopes that have already been built up in connection with nuclear power, it was disturbing to hear Mr. A. L. G. Lindley, director, General Electric Co., Ltd., assert that there were not enough men in the country to maintain the development. Earlier, Mr. Eccles had also issued a warning in respect of the supply of technologists and we think that the full seriousness of the position is stressed by Mr. Lindley's further statement that " industry is usually resilient to change by virtue of its existing technologists, but in this case the men are not there."

There was a call for greater sacrifices by the electrical industry in meeting the demands of the nuclear energy industry for technologists. The industry we know will do its utmost for it is more closely involved in nuclear energy developments, both scientifically and from an engineering aspect than is any other industry.

NUCLEAR LOAD FACTOR

Several speakers at the inaugural meeting of the British Nuclear Energy Conference stressed the great importance of a high load factor in connection with nuclear power stations, the capital costs of which are so much higher than those of steam stations as to make their idleness almost a crime. There are technical as well as economic reasons why a high load factor is desirable on nuclear plant and although it is at present feasible to use the few nuclear stations as base load plants, when their total output becomes comparable with that from steam stations, a load factor of 48 per cent will be unreasonable. The long-term view only emphasizes that intensive efforts should be made to develop demand during the off-peak periods, both industrial and domestic. Considerable differences exist between the various Electricity Boards in the tariff encouragement offered to such loads. From the national point of view it would seem that the unit cost should represent only the incremental cost of generation and transmission leaving all overheads to be carried by the normally metered load.

OFF-PEAK HEATING

In the South of Scotland, off-peak heating supplies, which have been considerably developed, are offered at about 0·75d/kWh, contrasting with 1·1d/kWh in the London area. This seems a large discrepancy and although London omits the installed kW charge for off-peak load this is only an obvious omission—such a charge would be difficult to justify for off-peak usage only. The Chancellor of the Exchequer should also actively encourage the conservation and maximum utilization of capital resources which off-peak loads encourage. Night storage heaters are at present not available to domestic users because they have been exempted from purchase tax for commercial or industrial use only and arrangements cannot apparently be made for only one class of customer to pay tax. This is deplorable as these heaters are not only an admirable source of continuous background heat in the home but an ideal electrical load. The importance of reducing the peak as well as filling the trough is the background to the description we publish this week of the trials being conducted by the C.E.A. at one of its housing estates in Yorkshire. It will be seen that attention is being given to the effects of numerous individual items: unfortunately no really concerted effort seems to be in sight.

ENGINEER-ADMINISTRATORS

A thoughtful letter from Mr. A. Jolly on " Engineers as Administrators " appears in the November issue of the *Electrical Power Engineer*. In this Mr. Jolly quotes Sir Henry Self and Lord Citrine as regarding engineers as generally unsuitable for the higher managerial positions. He considers that insufficient investigation among the technical staff has been made; if likely men were singled out and given the proper training in administration they would prove their worth. Mr. Jolly says:—" There are many who are engineers in their heads and administrators in their hearts and many who in fact believe that they will do increasingly well as they attain to administrative level." We have always encouraged the idea that engineers should wherever possible be given administrative posts but they must prepare themselves for such posts. It is only fair to point out that Sir Henry Self in his 1955 Power Convention paper recognized that something should be done to give engineers administrative training and said that the C.E.A. was testing the value of a range of courses run by various bodies for such a purpose.

THE AUTOMATIC FACTORY

The general principles of automation have been known and applied for many years, but only on a comparatively limited scale, and now that the maximum possible industrial productivity has become an absolute necessity for any country wishing to maintain its position in world markets the techniques of automation are being vigorously developed and applied. In this connection it is encouraging to learn that a British firm has for the first time developed a completely automatic milling machine which is now running successfully on regular production work. This has not been done anywhere else in the world. With this machine, which is described more fully elsewhere in this issue, substantial economies are effected in costs, time and man-power. The importance of the developments can be gauged from the fact that, with the new machine, it is possible to produce a certain cam in two hours using only semi-skilled labour; previously this task took about three weeks and required highly skilled labour. It can thus be seen that a machine of this kind would very quickly pay for itself and reduce considerably the cost of the end-product. Although our impressions of the machine are entirely favourable, it would appear that, having progressed so far, it would be both desirable and advantageous for the machine tool designer and the automatic control system designer to sit down together and co-operate wholeheartedly in the design of a completely new type of automatic machine tool, breaking away from the idea of adding electrical controls to an existing machine. This would be of benefit all round and would undoubtedly produce a far more efficient type of machine tool.

WIRING REGULATIONS

Differences between the requirements of the twelfth and the new thirteenth editions of the I.E.E. Regulations for the Electrical Equipment of Buildings were summarized in our issues of 2nd and 9th September. The most noticeable of these differences was a simplification of the text which involved extensive recasting and renumbering of the sections. Although this rearrangement appears to be a considerable improvement, it may at first make speedy reference difficult to those accustomed to associate certain numbered paragraphs with particular problems. The cross-reference index with introductory notes compiled by the Association of Supervising Electrical Engineers and obtainable free, apart from 2½d for postage, from its secretary at 23, Bloomsbury Square, London, W.C.1, should be most helpful, especially in the preparation of specifications.

Radioactive Isotopes

A SURVEY OF THEIR ELECTRICAL APPLICATIONS

By S. JEFFERSON

Isotope Division, A.E.R.E., Harwell

THE majority of radioactive substances which are used for industrial purposes give off either beta particles alone or both beta particles and gamma rays. The beta particles are better known as electrons but have more energy than is common for electrons in electrical engineering. To make a comparison, the electrons leaving an incandescent tungsten wire have energies which are not usually greater than 20 electron volts, while the energy of the electrons given off by radioactive atoms can be millions of electron volts. These high energy electrons are called beta particles to indicate that their energy is derived from radioactive decay.

A few words on atomic structure will give some insight into the difference in the mechanism of the release of electrons and beta particles. For the sake of brevity, the following description is limited to the bare essentials of a typical atomic structure and its nuclear changes. Each of the atoms of common aluminium has a nucleus, or core, made up of thirteen protons and fourteen neutrons. Each proton has a positive charge equal to the negative charge of an electron, while the neutrons have no charge. The nucleus is the centre of a system of thirteen electrons which orbit round the nucleus. The whole atomic layout is not unlike the solar system, with the sun replaced by the nucleus and the planets by the electrons.

The negative charges of the thirteen orbiting electrons balance the positive charges of the thirteen protons and so the overall charge is zero. The thirteen electrons give aluminium its chemical properties, but the number of electrons depends in turn on the number of protons in the nucleus.

One way of disturbing atomic nuclei is to bombard them with free neutrons which, having no charge, are able to pass the orbiting electrons. An atomic pile contains a high flux of free neutrons and if some common aluminium is introduced, some of the aluminium nuclei will acquire an extra neutron. Each of the atoms with an extra neutron will still be aluminium, but will have a higher atomic weight than common aluminium. Atoms of an element which have different atomic weights are called isotopes of the element. They are usually designated by the chemical symbol and the mass number, which is the number of neutrons plus protons in each atom, the mass of the electrons being negligible in comparison. Thus common aluminium is Al27 and the atoms with an extra neutron each are Al28. The presence of the extra neutron in aluminium 28 results in an unstable arrangement and there is a tendency for the extra neutron to change into a proton and an electron, which is thrown out as a beta particle. The beta particles ejected by the unstable aluminium nucleus can have energies up to 3 MeV which enable them to travel through the air for distances up to 12 m compared with a range of less than 0·1 mm for electrons leaving a hot filament.

In the case of the radioactive aluminium nucleus which we have been considering, the release of a beta particle does not reduce the atom completely to a stable condition and in consequence a gamma ray is emitted as well to get rid of the surplus energy. Gamma rays are electromagnetic radiations like X-rays, light rays, and radio transmissions. Gamma rays in general have more energy than X-rays and so they can penetrate a greater thickness of material. For instance, X-rays from a 160 kV machine which have a mean energy of about 80 keV will be reduced to one per cent by about 1in of steel. Gamma rays from radioactive cobalt 60 have energies of 1·1 and 1·3 MeV and about 5in of steel is required to reduce the initial gamma radiation to one per cent. When the beta particle and gamma ray have been emitted, the nucleus is left with fourteen protons and fourteen neutrons, which is no longer the nucleus of aluminium, but the nucleus of one of the stable isotopes of silicon (silicon 28).

All radioactive substances reduce their radioactivity exponentially with time, each radioisotope having its own characteristic rate of decay. It has been found most useful to indicate each rate of decay by the length of time taken for the activity to fall to half its intensity at the arbitrary beginning of the measurement. This length of time is called the half-life of the radioisotope. In two half-lives the activity falls to a quarter, in three half-lives to an eighth, and so on. The half-life of aluminium 28 is 2·3 min which makes it of little use as a radioisotope.

In choosing an isotope for a particular purpose, its half-life is an obviously important consideration. The half-lives of the several hundred available radioisotopes are scattered through a very wide range of values from microseconds to thousands of years. In consequence the other properties required of the radioisotope, such as the type and energy of the radiations can usually be found in combination with a convenient length of half-life.

We can now turn to some applications of radioactive elements. As a first example, the beta particles from a radioactive source can be used to ionize a gas. The ionization arises because the high energy of the beta particles enables them to dislodge electrons from the atoms of the gas leaving the atoms positively charged (positive ions) and the electrons free of ties for the time being. A positive ion and a free electron are known as an ion pair, and if the electron has enough energy after separation it can, in turn, produce more ion pairs.

This ionizing action can be employed in cold cathode tubes to stabilize the striking voltage. When a rising voltage, such as the leading edge of a pulse, is applied between the anode and cathode of a cold cathode tube, the discharge does not start until the gas between the electrodes is ionized to some small degree. In cold cathode tubes operating in daylight the initial ionization usually arises from the electrons released by the photo-electric effect of the daylight on the surface of one of the electrodes. When cold cathode tubes are used in the dark, for instance in enclosed apparatus, the initial ionization depends on the passage of cosmic rays and natural radiations. The intervals between these are so large that the striking voltage may rise by more than 20 per cent, which is too great a variation for all but the simplest of circuits.

In order to produce a continuous low level of ionization,

natural radioactive materials such as radium have been introduced into cold cathode tubes for many years. The ionizing action has been quite satisfactory, but the materials used until recent months have also given off gamma radiations which easily penetrate the walls of the cold cathode tubes and any boxes into which they might be packed. In consequence a collection of cold cathode tubes embodying natural radioactive material had a serious amount of gamma radiation on the outside of the bulk packages.

Advantages of Tritium

A pile-produced radioisotope which is particularly suitable for the ionization of the gas in cold cathode tubes is tritium, an isotope of hydrogen. The merits of tritium are:—

(*a*) It emits beta particles and no gamma rays.

(*b*) It has a half-life of 12 years.

(*c*) Its beta particles are weak and cannot penetrate the glass walls of a cold cathode tube, i.e. no radioactivity can be detected on the outside of a cold cathode tube containing tritium.

(*d*) The low energy of its beta particles enables them to give up most of their energy in producing ionization in the limited volume of a small cold cathode tube.

(*e*) Tritium is one of the least dangerous of all radioactive isotopes because it is not retained in the body for more than a few days and on account of the low energy of its beta particles which have a range of a few microns only and cannot penetrate the skin.

It has been found that about 100 microcuries of tritium in a cold cathode tube is quite adequate for producing a steady supply of ionization. The main problems in this particular application lie in the choice of method of inserting the tritium into the cold cathode tubes. The most obvious way is to mix the tritium with the argon and other gases which are used for filling the cold cathode tubes. This method is wasteful, because the volume in the header system used for the filling operation is usually several times the volume of the tubes themselves, and it is current practice to jettison the unused gas from the header tubes.

A more economical method is to store the tritium on a mass of finely divided uranium (pyrophoric uranium) in a part of the filling system. The tritium can be driven off the uranium by heating and can be recovered on to the pyrophoric uranium by cooling it again (Fig. 1). While the tritium is free in the filling system, some of it can be laid down on the glass walls of the cold cathode tubes by producing a high-frequency discharge from one of the internal electrodes to another electrode on the outside of the cold cathode tube envelope. Having been combined with the glass on the wall, the tritium remains there and can emit its beta particles in the desired area.

Spark gaps used for limiting the voltages in high voltage testing can also be made to operate within closer limits by means of ionizing radiations. The ideal position for the radioactive source is inside one of the spheres of the gap, because this arrangement leaves the field pattern undisturbed. The disadvantage is that the radioactive source must be protected and adequate protection is a serious barrier to beta particles. Gamma ray sources can be protected without much loss of strength, but gamma rays are roughly one-hundredth as effective as beta particles in ionizing the air. The choice lies between a strong gamma ray emitter in one of the spheres and a beta particle emitter situated far enough to one side of the gap to avoid disturbing the field pattern between the gaps. The beta particles from thallium 204 have ranges in air up to 7ft and fortunately the ionization produced by a beta particle increases as the velocity falls.

Another application for the ionizing effects of beta particles is in reducing electrostatic charges on insulating materials (Fig. 2). The formation of static charges on such materials as textiles, paper and plastics, can occur in several ways. The most common is by friction with either a conducting surface or another insulating material. Less commonly the charge appears after the separation of one insulating material from another. In this latter case, the charge is formed by the electrons at the interface having drifted over from one material to the other and not being able to return quickly enough when the two surfaces are separated.

The charge on insulating materials can be conducted away by ionizing the air in the region of the charges. Since the amount of ionization produced by practical radioactive sources is limited, a certain amount of time must elapse before the charge is materially reduced. It has been found in practice that when materials are travelling at a speed in excess of two feet per second it is not usually possible to discharge them by existing sources.

Cable Gas Leak Detection

Turning to quite a different subject, we can often find leaks by making use of the ease with which extremely small quantities of radioactive material can be detected. One of the applications of interest to electrical engineers is the locating of leaks in pressurized high voltage electric cables. One way of doing this is to add a shot of radioactive gas to the nitrogen which is usually pumped into the cable to make up the loss from the leaks, and to follow the course of the radioactive gas along the cable. This can be done at intervals of a few yards and when it is found that the radioactive gas is no longer travelling along the cable it can be assumed that the leak is in the section of cable just traversed.

One of the most useful gases for this purpose is radon or, as it is sometimes called, radium emanation. The particular merit of radon is that it does not decay directly to stable material, but decays into solid matter which is itself radioactive. In consequence of this type of decay,

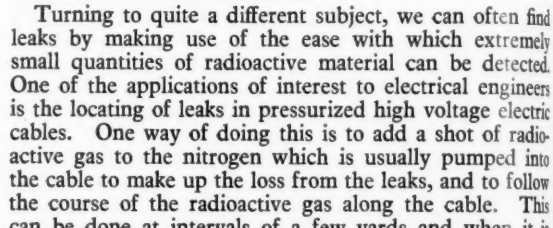


Fig. 1.—Pyrophoric uranium furnace

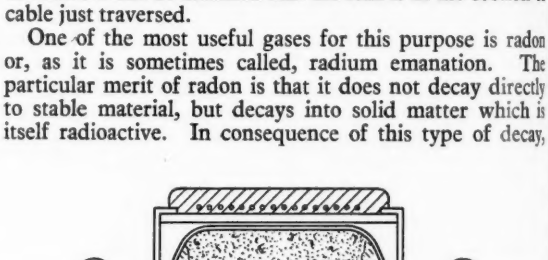


Fig. 2.—12in static eliminator

radon leaves a trail of radioactive material as it passes along a cable. Should the radon leak out of the cable and rise to the surface of the ground, the radioactive trail of solid decay products continues up to the surface. The trail of radioactive material near the surface of the ground is an excellent guide to the position of the leak after the approximate position of the leak has been found from the radon failing to arrive at one of the observation points on the cable.

The half-life of radon is 3·8 days and its practical use is limited to places within fifteen days' travel of the supply point. This consideration does not apply to many parts of the world, but the need to find a leak is usually urgent. Fortunately, enough radon for a single test can be collected from about 5 to 10 milligrams of radium. The radium salt can be stored in an apparatus shown diagrammatically in Fig. 3. The system is connected into the high-pressure feed at points A and B. Tap T_1 is normally open and taps T_2 and T_3 closed. The radon is collected in the space C above hydrated ferric hydroxide D on which radium bromide has been deposited. $Fe_2O_3xH_2O$ is chosen because it has a large surface area to encourage the release of radon from the radium salt. With hydrated ferric hydroxide it is possible to get an 80 per cent yield of radon. To inject the radon, the tap T_1 is closed and taps T_2 and T_3 are opened for a few seconds, which is enough for the filling gas to sweep the radon out of the enclosure C. One limitation of this method is that the apparatus cannot be used frequently, because it takes about 30 days for the radon to accumulate to its full strength. Since the radium salt and the decay products of the radon in the chamber C emit gamma rays, it is necessary to screen this part with lead, denoted by E.

Where radon can be obtained quickly, it is usually supplied in the form of small gold or aluminium seeds. These seeds are notched to ease opening and releasing the radon.

Methyl bromide is another radioactive gas which has been used successfully for detecting leaks in high-pressure cables. The half-life of this gas is 36 hours which puts an even more severe limitation on the permissible time of travel. Methyl bromide (bromine 82) decays into selenium 82 which is stable and so there is no trail of radioactivity left after the active gas has passed along the cable or through the soil.

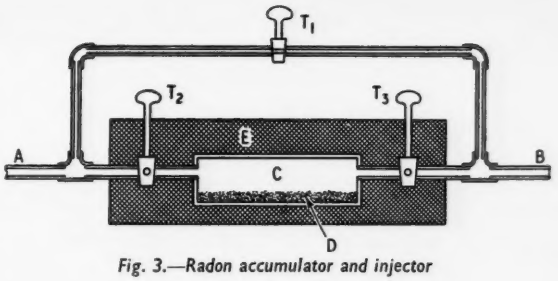


Fig. 3.—Radon accumulator and injector

Testing Submarine Cable Repeaters

Submarine cable repeaters have to operate under extreme pressure of sea water for periods of 20 years or more without any serious amount of moisture accumulating inside. In designing the sealing glands for these repeaters, it is most desirable to be able to speed up the tests for leakage so that they can be repeated quickly under different conditions. Owing to the ease with which extremely small quantities of radioactive water vapour can be detected, it is possible to measure within an hour a leak rate that would only be serious if it were maintained for 20 years. Radioactive water is formed by burning tritium gas, which is a radioisotope of hydrogen. The water so formed has some of its molecules made up of two tritium atoms and one oxygen atom and other molecules made up of one tritium, one hydrogen and one oxygen atom. Because the tritium (H^3) atoms are part of the water molecules, their radioactivity will follow the water in any phase, solid, liquid or vapour.

One arrangement for testing the sealing glands of submarine repeaters is shown in Fig. 4. The metal side of the gland A is attached to the steel block B and a high pressure of tritiated brine is applied outside the gland C. Any tritiated water vapour which leaks through the gland is collected in the hole D, which normally carries the cable.

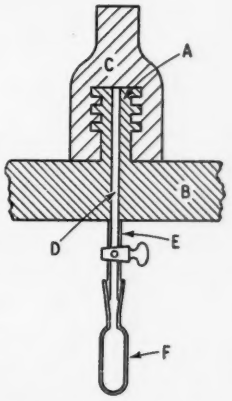


Fig. 4.—Arrangement for testing a submarine cable repeater gland

The hole D is connected through a tube E to a glass tube F. At the end of the test period the bulb F is cooled until any tritiated water vapour in D is deposited as tritiated ice on the walls of the bulb. The bulb F is then removed and coupled into the filling system of a demountable Geiger counter. The bulb is kept cold while the filling system is evacuated, and then heat is applied to convert the ice back to water vapour. The Geiger counter is filled with a standard mixture of argon-alcohol and the tritiated water vapour. The extent of the leak is estimated from the measurement of radioactivity by the Geiger counter.

In the manufacture of germanium diodes it is essential that the germanium should have an extremely high degree of purity. The required purity is not only difficult to achieve, but is also difficult to measure; normal chemical and spectrographic methods have proved inadequate. A new method of analysis, called radioactive analysis, makes use of the possibility of irradiating the germanium and its impurity in the neutron flux of a pile, and so making the impurity radioactive. In the case of germanium, the most troublesome impurity is arsenic. By irradiating the germanium and subsequently extracting the arsenic, its weight can be measured by means of its radioactivity. During the extraction process a known small quantity of inactive arsenic is added in order to ease the handling of the extremely small quantities involved, without affecting the amount of radioactivity. The whole process is made comparative by irradiating a known weight of arsenic compound at the same time and under the same conditions as the sample of germanium to be analysed. A known weight of inactive arsenic is also added to the known amount of arsenic compound, the pair of chemical manipulations going on side by side through all stages. Finally, the specific activities of the two arsenic extractions are compared. The specific activity is directly proportional to the amounts of arsenic irradiated, provided that the amount of added inactive arsenic is the same in both cases. Using this method, germanium samples containing arsenic in the proportion of 5 parts per thousand million of germanium have been successfully analysed.

When a flux of beta particles from a radioactive source falls on to a target, the transfer of the large number of negative electric charges constitutes a small electric current. If the target is insulated, then as the beta particles continue to arrive, the negative potential of the target increases. If now an external load is connected between the target and the radioactive source, a small load current can be

drawn off. The voltage between the target and the radioactive source will be maintained so long as the load current does not exceed the current carried by the beta particles. Such an arrangement, consisting of a radioactive beta-particle emitting source and an insulated target is called an atomic battery. This type of battery has the advantage that its life is dependent only on the half-life of the source. Since one of the suitable radioactive sources is strontium 90 with a half-life of about 20 years, this advantage over normal batteries can be considerable. However, the current which can be drawn from such a battery is minute: $6{\cdot}2 \times 10^{18}$ electrons are required to make up one coulomb, and the size of source which is currently practical is 100 millicuries, giving $3{\cdot}7 \times 10^{9}$ beta particles per second. Assuming 20 per cent collection of the emitted beta particles on to the target, the maximum current which could be maintained indefinitely is $1{\cdot}2 \times 10^{-4}$ microamps. There is, of course, the possibility of charging up a storage condenser which could supply a larger current for short periods. The arrangement of an atomic battery is shown diagrammatically in Fig. 5. The radioactive source A is separated from the target B by an insulating layer C.

If an antimony-silicon junction is irradiated by beta particles, an increased e.m.f. is developed across the junction. The current which can be drawn from this type of atomic battery has recently been claimed to be about 10^5 times larger than from the simple type.

In this short article, I have only been able to touch upon a few typical examples of the application of radioisotopes to electrical engineering. The Isotope Division, at the Atomic Energy Research Establishment, Harwell, operates a free advisory service in the use of radioisotopes for specific problems, and in the specialized techniques involved. Inquiries by post are answered, and where the problem justifies longer discussion, consultations are held by appointment at Harwell. In the past, considerable use of this facility has been made, especially by industrial users. Anyone who is in doubt about possible applications of radioisotopes, or the methods by which they may be employed is invited to address his queries to the Isotope Advisory Service before embarking on a research programme.

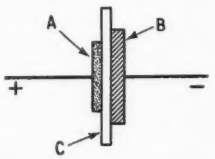


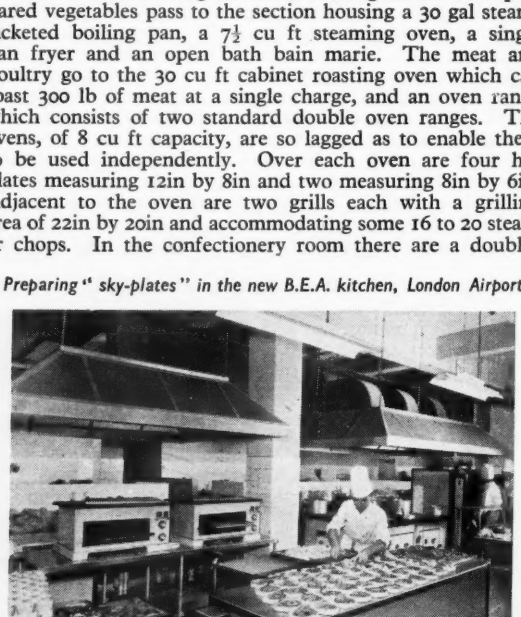
Fig. 5.—The simplest form of atomic battery

London Airport Kitchen

ON Friday next week, the Queen will inaugurate the new building at London Airport. A feature of the Airport is the B.E.A. aircraft catering kitchen in which, on an average day, 1,200 hot meals and 800 cold meals for some forty-two plane services have to be prepared. The General Electric Co., Ltd., which was the main contractor for the complete supply, erection and installation of the kitchen, including all services, has now completed the cabin services room, which finally brings the kitchen into full operation.

The larder, stockrooms and 650 cu ft cold room lead directly to the meat and vegetable preparation sections, these sections in turn feeding the main cooking areas. The prepared vegetables pass to the section housing a 30 gal steam-jacketed boiling pan, a 7½ cu ft steaming oven, a single pan fryer and an open bath bain marie. The meat and poultry go to the 30 cu ft cabinet roasting oven which can roast 300 lb of meat at a single charge, and an oven range which consists of two standard double oven ranges. The ovens, of 8 cu ft capacity, are so lagged as to enable them to be used independently. Over each oven are four hot plates measuring 12in by 8in and two measuring 8in by 6in. Adjacent to the oven are two grills each with a grilling area of 22in by 20in and accommodating some 16 to 20 steaks or chops. In the confectionery room there are a double-deck pastry oven, a twelve-tray proving oven, a boiling table and a 50-quart capacity mixing machine. A similar machine is installed in the main kitchen.

Preparing "sky-plates" in the new B.E.A. kitchen, London Airport



The cooked food passes from these cooking areas to "sky-plates." To keep the food hot these are loaded into electrically-heated containers developed by the G.E.C. for use on aircraft electrical circuits. To heat the containers while still in the kitchen the G.E.C. has constructed two container racks each fitted with two double-wound, step-down transformers having an output of 2,000 VA and a voltage ratio of 230/28 V. Each rack is designed to accommodate 20 packed containers. When an aircraft is about to leave, the containers are unplugged from the racks and taken by trolley to the aircraft galley and there plugged on circuit again until the food is required. Beyond the heated container racks is a tea and coffee dispensing unit, to the left of which is the washing-up area and to the right the aircraft servicing trolley loading bay. In both the general washing-up area of the kitchen and in the recently completed cabin services room are a fully automatic dishwashing machine and a calorifier for providing rinse water. Apart from the items already mentioned the kitchen has a 28 lb capacity potato peeler, a power unit with slicer, chipper and grater plate attachments, a mincing machine and many small items.

Services provided within the kitchen by the General Electric Co. include the specially designed main electrical switchboard, distribution board and local control gear, and the supply and installation of all wiring ducts, conduits, and circuit wiring, including final connections to all equipment. A G.E.C. 2in by 1½in under-floor ducting system is employed for the wiring.

The architect for all work carried out at London Airport is Mr. F. Gibberd, C.B.E., F.R.I.B.A., M.T.P.I. The consulting engineers are G. H. Buckle & Partners for mechanical services, and Ewbank & Partners for electrical services. Installation sub-contractors were:—Electrical installations: London Electricity Board; mechanical services: G. N. Haden & Sons, Ltd.; waste pipes and fittings, Dent & Hallyer Sanitation, Ltd. The main equipment sub-contractors were:—Steam cooking equipment: Carron Company; tea and coffee equipment: W. M. Still & Sons, Ltd.; kitchen machinery: Hobart Manufacturing Co., Ltd.; stainless steel sink fittings, racks, benching and tables: Staines Kitchen Equipment Co., Ltd.; 650 cu ft cold room: Pressed Steel Co., Ltd.; and ventilation canopies: Airstream Metal Products, Ltd.

Domestic Electrical Usage

The title picture shows a view of experimental all-electric terrace

LARGE-SCALE TRIALS ON ESTATE FOR C.E.A. STAFF AT KEADBY

To provide accommodation for married staff of an extension to Keadby power station in Yorkshire, the Central Electricity Authority is adding 90 terrace houses to an already existing estate for station staff. Although, owing to the relatively larger proportion of shift workers and the closeness of the place of work, these new domestic consumers could not be regarded as representative of majority conditions, it was felt that the opportunity might be taken to carry out certain large-scale trials which in previous attempts in connection with ordinary housing developments had proved difficult to arrange. The extension to the estate is now nearing completion, and below are outlined the special arrangements made under the ægis of the Utilisation Research Committee of the Authority and Area Boards.

Load Characteristics

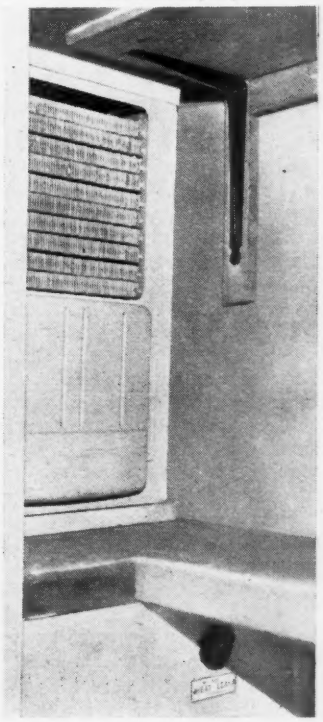
With the exceptions referred to later, each house (average floor area about 1,000 sq ft) is fitted with a solid-fuel fire and back boiler in the living room, a 30 gal hot-water cylinder with 2 kW immersion heater, and a single-boiling-plate electric cooker. A three-phase, four-wire service is led into each house, with a separate meter for each phase; all the lighting and socket-outlet circuits being connected to the "red" phase, the cookers to the "yellow" phase, and the water heaters to the "blue" phase. In view of the unbalance thus created, larger cross sections have been used for the distributors than would normally be necessary, but it will be appreciated that this scheme enables separate records to be obtained of the cooking load, water-heating load, and remaining load, not only for the aggregate of consumers, but also for smaller groups. For this purpose, recording instruments have been installed at the substation in all three phases, to be kept in continuous operation, and provision made for inserting additional recorders in all feeders and at two points in the distribution system, where sheet-metal pillars have been provided specially to accommodate them.

In this way it will be possible to study separately the characteristics of the cooking, water-heating, and remaining loads of the part of the estate in question, also the effect of the weather, etc., and trends due to the acquisition of additional appliances. Moreover, data on the relation between after-diversity-maximum demand per cooker, water heater, etc., and size of group will ensue, while the meters, which will be read monthly, will give the individual households' consumptions for cooking and water heating. There is also a water meter in the cold feed of each hot-water cylinder.

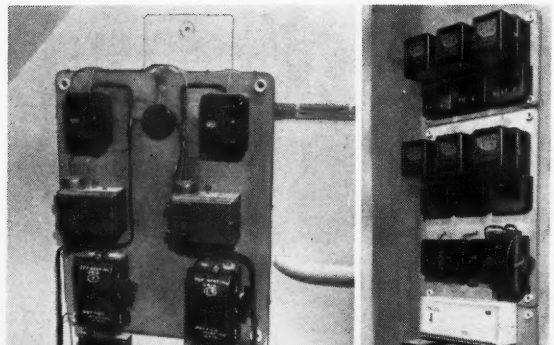
As a further feature, each cooker-control unit is combined with a switch for the immersion heater, interlocked so that both appliances cannot be used together. After a year's operation, the interlock will be removed, and the substation load records for the following year will show what effect the change-over switch had on the water-heating load at times of system peaks.

In view of the different efficiency of boiling plate, grill boiler, and oven, their relative use is of interest, especially in connection with the economies possible by using only special cooking utensils with solid boiling plates. One in every four houses, therefore, has the cooker wiring segregated and the consumption of these three elements metered separately. Subtraction of their aggregate consumption from the total cooker-circuit consumption will give the consumption of the kettle with which each household is issued; a non-standard plug and socket makes it inconvenient to plug any other appliance into the cooker circuit. Detailed information of this sort will thus become available from some 20 households.

Larder heat pump



So as to investigate the comparative performance, consumption, consumer appeal, and maintenance costs of solid and radiant boiling plates, alternate cookers are initially equipped with solid and radiant boiling plates, respectively, which after a year's operation will be interchanged for another year's run.



Control gear (left) and metering (right) in a floor-heated house

Thus, every household will use for one year a solid boiling plate, and for a similar period a radiant one. Experimental accuracy is ensured by supplying free of charge sets of three ground-black-base utensils, and the statistical analysis of the annual cooking consumption of the 90 households is expected to reveal whether, and what, savings in consumption are possible by the use of radiant boiling plates. At the end of the second year, the households having a solid plate will be given the option to keep it or have their radiant one back, whereas the cookers of the other half will be fitted with radiant grill boilers for a year. Records will be kept of maintenance costs, and consumers' opinions surveyed.

Experimental Houses

Arising from suggestions made in an I.E.E. paper by Mr. D. H. Parry,* a terrace of six 3-bedroom houses has been equipped with special thermal insulation to give an overall U-value of about 0·1, and with electric floor heating in living rooms and dining kitchens. To reduce the heat loss to an economic minimum, the cavities of all external and party walls have been filled with bitumen-bonded fibreglass, porches with additional doors added to front and rear doors, and all windows provided with double glazing. The heated floors, with a loading of 1·6 kW for the living room and 1·2 kW for the kitchen, consist of plastic tiling and a 4in concrete screed, insulated by 1½in cork slabs (laid in bitumen) from the concrete slab on which the houses rest; edge insulation is provided where advisable.

In order to study the effect the position of the heaters in the screed has on the performance, especially the thermal storage capacity, two complete and independent grids of Pyrotenax cable with Kumanal core have been embedded, one laid direct on the cork, and the other 3in above. They are controlled by change-over switches, mounted on a panel in an under-the-stairs cupboard, together with the switch-heads of floor thermostats (connected by capillary tube to bulbs embedded in the floors) and the main switches for the floor heating of living room and kitchen. Two small (normally boxed-in) buck/boost transformers are provided for experimental purposes to enable the heating voltage, and thus the kW loading, to be varied within certain limits. Further, the installations of all six houses are jointly controlled by a MacLaren thermo-time regulator, mounted in the supply feeder pillar. While the off-peak tariff of the Yorkshire Electricity Board requires the heating circuits to be disconnected from 7 a.m. to 12 noon, and from 3 to 6 p.m., this instrument automatically adjusts the length of the periods during which they are connected to the supply in accordance with the outdoor temperature. In addition, an air thermostat has been installed in each heated room, but may prove unnecessary if the common regulator comes up to expectations.

For the trial period of three years, all thermostats will be sealed and the floor heating supplied by the Authority at a fixed weekly charge. As it is not intended to give full comfort heating under all conditions, a supplementary electric glow fire, consisting of two 250 W carbon lamps is fitted in each living room and a radiant glass panel on the wall of each kitchen. The heat output of the latter can be varied by a Simmerstat-type switch. In the bedrooms, only socket-outlets have been provided.

A chimney is provided in each of the six houses as, having regard to the experimental character of the scheme, it was decided to give every tenant an opportunity to adopt solid-fuel heating if he so desired at the end of the trial period. All necessary structural provisions have, therefore, been made, with the flues blocked up at both ends. For the same reason, hot-water cylinders similar to those in the other houses have been fitted in the airing cupboards and adapted for possible future connection to a back boiler.

Larder Heat Pumps

It was also thought opportune to try out combined larder cooling and water heating by means of a heat pump, but as at the time no commercial units were available, an offer of the E.R.A. to make up six experimental ones was gratefully accepted. So as to avoid electrically-generated heat being drawn from the kitchen, the internal larder walls and the door have been specially insulated.

The sealed compressor unit and the condenser are enclosed in a 15 gal auxiliary tank placed under the larder shelf and connected by well-lagged flow and return pipes to the hot-water cylinder. In the accompanying illustration, where this tank is hidden by a plywood panel, can be seen an ice-making box and the evaporator for larder cooling, at the back of which a fan is mounted. To ensure sufficient hot water being produced in cold weather, an additional evaporator is mounted externally and controlled by appropriate change-over valves. On the other hand, an automatic heat leak enables the larder cooling to function in warm weather even if the cylinder is full of hot water and its thermostat has cut out. For emergency use, a standard immersion heater has also been fitted.

To derive all possible benefit from these heating trials, ample instrumentation has been provided. In addition to the three meters fitted in all houses, separate meters have been installed for the living room and kitchen floor-heating circuits, and for the heat pump. All the meters are mounted over the service intake in the store room. One of the store rooms of the experimental terrace also accommodates a 12-point temperature recorder with a set of change-over relays for use in conjunction with 24 thermocouples, which measure the temperature of the floor-heated rooms, the larders, and the hot-water cylinders, those for the rooms being enclosed in blackened globes suspended from the ceilings. Furthermore, the E.R.A. has been enabled to carry out scientific tests on the heat flow from the floors and other performance details, and to install for this purpose numerous additional thermocouples, connected to a multi-point temperature recorder.

* "The Logical Approach to the Problems of Space Warming by Electricity," *Proceedings I.E.E.*, 1952, Vol. 99, Part I, p. 233.

VIEWS on the NEWS

By REFLECTOR

DURING a recent political broadcast on B.B.C. television a small farmer spoke of the benefits which electricity had brought to him and clearly implied that without electricity the farming industry could not progress. In such a programme the deduction intended to be made was that the party responsible for the broadcast had been the fairy godmother. Actually, no political party can really claim credit for what has been done. Politicians make great play with the magic phrase " electrifying the countryside " but the work has actually been done by the electricity supply authorities with little active help from the Government in power. Now, the effect of the restrictions on Electricity Boards' expenditure seems likely to be the retarding of rural development.

* * *

From time to time I have been asked about the liability of electricity authorities to compensate consumers for any losses which they may suffer through a stoppage of supply. During and since the war the authorities' statutory obligations in this regard have been somewhat modified and I have not been bold enough to express any opinion. In Canada (and maybe here) it is possible, for a suitable premium, to transfer the onus of compensation to insurance companies. It was reported last week that Lloyd's have paid out a million dollars and are expected to pay more than this to a copper firm which incurred a loss of revenue through the failure of electricity supply. Four underwater cables were installed to take power to the company's works and the policy provided for a payment of $1,000 for each day the power was not available. Apparently power was not received for 377 days, which resulted in the heavy payment mentioned. The premium paid was $10,000; with the conditions prevailing in this country " cover " should be secured much more cheaply by British industrial consumers.

* * *

Farmers are usually regarded as being close to the land, but, while still doing their work, they appear to be tending away from it. Speaking at a recent ceremony Mr. R. B. Anderson of the North of Scotland Hydro-Electric Board, said (according to the *Scotsman*) that the idea of a Scottish farmer working his machinery in the field by remote control was not far-fetched. I visualize the time when the Scottish farmer may join his compatriots in London and, assisted by television, carry out his operations from there. After all if control is remote distance need be no object.

* * *

The *Kinematograph Weekly* reports a meeting at Leeds at which representatives of the Cinema Exhibitors' Association told an official of the West Riding County Council that the Council's form of certificate for cinema electrical installations was too complicated and that the form recommended by the Home Office was quite adequate. The requirement was that installations should be safe and satisfactory; they could only be that or unsafe and unsatisfactory. Regarding electrical installations generally I do not agree. I have seen many installations which have been safe but have been most unsatisfactory in other respects. The question is, I suppose, who has to be satisfied?

* * *

A reader in Victoria, British Columbia, has sent a copy of the journal of the International Brotherhood of Electrical Workers, an American trade union which also operates in Canada. It is attractively produced and copiously illustrated. Most of the contents report the varied activities of the membership, much attention being paid to the technical side of their work, but there are several articles of wider interest. The general tone is optimistic. I also have before me the current issue of *Electron*, the official journal of the Electrical Trades Union. This presents a severe contrast to its American counterpart. There is far too much political rancour; almost everybody outside the " movement " appears to be regarded as an active enemy. Most of the electricians I know are healthy, normal and likeable men who bear no signs of the continual face-grinding to which (it would seem from *Electron*) they are continually subjected. I know they always want more pay—but who doesn't?

* * *

From a report of a meeting of one of the sections of the E.P.E.A. appearing in the November issue of the *Electrical Power Engineer*:—

> " Cato, the Roman censor, used to end every speech on whatever subject with the cry 'Carthage must be destroyed.' He had his brother in our meeting in the form of Mr. ———. His *delenda est Carthage* was 'the cost of living in Leatherhead.' His ingenuity in raising it in any context whatever throughout the meeting excited admiration from one and all."

* * *

Just after reading in last week's *Electrical Review* the report of the Principal Electrical Inspector of Mines for 1953 (belatedly issued as usual) I came across a leading article dealing with mine lighting published in the *Electrical Review* of 5th December, 1885 (seventy years ago). It concluded with the following paragraph:—

> " This question of illumination is perhaps the most important in which the employment of electricity enters; but there are other means of using that volatile and versatile force in the dark regions underground . . . . Sir William Siemens was the pioneer in the introduction of electric hauling arrangements for mining work, while electricity has of late commenced to play an important part in signalling between the surface and underground. Whether electricity will ever entirely supersede other methods, either of illumination or haulage we cannot say, but we may safely assert that the improvements which are continually being made in its various applications will render it increasingly difficult to overlook its undoubted merits of safety and efficiency."

Automatic Control Systems

PRINCIPLES underlying two independently developed systems of automatic control, process and servo-motor, were discussed in a paper presented by Dr. G. O. Forester at a meeting of the South Wales Institute of Engineers at Cardiff on 8th December. Their common basis, he said, was that "information" was fed back from a later (output) stage to an earlier (input) stage, initiating action that corrected any error.

Process control maintained desired values of physical variables, such as temperature and pressure, usually by means of a valve. Servo-control regulated, by means of an electric motor, mechanical properties, particularly repositioning of a load, and electrical quantities. Limitations to accuracy were caused by random fluctuations in measured variable and inherent errors in the system and by delays in sensing and correcting errors, which the controlling system might actually aggravate through setting up oscillations (instability).

A marked difference between the two principles was due to the loads dealt with by each. In a closed-loop system the effect of the signal in each stage in the sequence must be known to secure correlation of theory and practice. In servo-control the mechanical load with its inertia and damping could be measured by the designer, whereas in process control the effect of plant, such as heat exchangers and fractioning columns, could not so readily be calculated to give a satisfactory guide to performance.

After giving several examples with diagrams of systems in which relationships of interdependent conditions were all linear, the author turned to non-linear controllers, which were discontinuous in action, particularly electrical ones involving relays. The instances cited in this case were mainly of temperature regulation, a simple form of which was "on-off" control in which a resistance-thermometer sensing element provided one arm of a Wheatstone bridge. Out-of-balance in the bridge (the error) was detected by a polarized sensitive relay, which acted as an amplifier, the contacts making circuit only on out-of-balance due to the sensing-element temperature being too low.

An adjustable resistor might replace the sensing element, the polarized relay making different contacts according to the sense of the out-of-balance. The secondary-circuit current passed in one or other direction through the armature of a motor whose field was fed with a constant current. This motor, besides positioning the load, altered the adjustable bridge resistor. Various types of non-linear controller were described under the headings of: Inching; follow-up; on-time, proportional to error, direct-action, or percentage-on-time; on-time proportional to error with integrator.

The remainder of the lecture was devoted to the feedback control of machines in an automatic factory. One illustration related to an automatic profile miller in which an electric servo positioned the cutter relative to the work according to the movement of a stylus on a template. In a later development the information was stored on a magnetic tape instead. The preparation and use of this information was then transcribed and elaborated by a computor of either the analogue or digital types. The former was simpler and functioned in terms of voltage signals, but the digital type was capable of great accuracy. As its outputs were recorded on magnetic tape, they could be used to control a number of machines.

Advantages of servo-control included the following: Saving in time and expense of tooling for conventional machinery methods; production of a prototype and subsequent parts to the same instructions with accuracy; considerable reduction in inspection of finished parts; increased utilization rate of machine tools, because the information could be fed in as fast as the machine could use it, instead of being limited by the speed of manual operation.

Lighting and the Architect

MODERN concepts of interior lighting were discussed by Mr. J. M. Waldram, president of the Association of Public Lighting Engineers at the meeting of Liverpool Centre of the Illuminating Engineering Society on 22nd November. The audience included members of the Royal Institute of British Architects and the Liverpool School of Architecture and Liverpool College of Building.

Mr. Waldram emphasized that if the architect knew his objective, lighting engineers had at their command the means by which his aims could be achieved. He described how the various techniques were applied.

Mr. G. L. Butler, chairman, said without light appreciation of architecture was lost. The architect who planned a building must control how he wanted his art to be revealed. The architect could prescribe lighting treatment but the lighting engineer had to dispense the prescription.

Mr. A. Wilcock (E.L.M.A. Lighting Service Bureau, Manchester), said he was worried by the suggestion that the lighting engineer would be able to dispense light to the prescription of the architect. He was not sure that the architect was interested in prescribing light. His feeling was that in most cases the engineer was obliged to use his own resource and initiative to prescribe as well as dispense. Basic training enabled engineers to prescribe in terms of lumens and other measurements but nobody spoke in terms of light from the standpoint of architectural light and shade. Would this result in some modification in the system of training? He was not at all sure how brightness pattern could be arrived at without bringing in the question of adaptation.

Mr. Waldram said that particular meeting, with architects present, was an example of how co-operation in lighting matters could be developed. It was probably fair comment that architects mainly visualized what a building would look like in daylight and regarded artificial lighting more as an embellishment. They forgot that lighting by night had the purpose of revealing the rest of the work.

Semi-Conductor Diodes

DURING the course of a lecture to the Television Society Mr. J. I. Missen, of the G.E.C. Research Laboratories, gave an interesting demonstration of the capabilities of modern medium area silicon junction rectifiers. The high efficiencies and good reverse voltage characteristics of the devices were shown in a typical h.v. supply using two rectifiers in series to provide 250 mA rectified current from a 50 c/s mains supply. The silicon junction device not only gives a higher voltage than a comparable selenium rectifier, but has the additional advantages of being smaller, free from ageing, and capable of operation at a higher ambient temperature. Mr. Missen gave a brief explanation of the operation of the semi-conductor junction diode and went on to consider its advantages over the selenium and copper oxide types. He reviewed the properties of semi-conductor diodes under the heading of forward and reverse characteristics, capacitance and operation at high temperatures, as well as their limitations at high frequencies. It was concluded that by using both silicon and germanium point contact and junction types, all possible requirements for diodes could be met.

PARLIAMENTARY REPORT

IN the final debate in the House of Commons on the purchase tax clause of the Finance Bill, Mr. Nabarro pleaded for equal treatment for tax purposes of the four methods of space and water heating—solid fuel, electricity, gas and oil—and for free competition between them. This Bill perpetuated the extraordinary anomaly that solid fuel appliances and oil appliances for heating rooms or water were free from purchase tax, but gas and electrical appliances were subject to purchase tax at a rate now increased from 50 to 60 per cent.

The position could be illustrated by taking the different types of domestic water-heating boilers referred to in the Bill. He commended the figures to the Chancellor of the Exchequer because he could find no reason for the discrimination. As a basic figure a rating of 45,000 B.Th.U./hr had been taken as approximately the average size of the usual domestic boiler. In the case of a well-known make of solid domestic fuel boiler with a rating of 46,000 B.Th.U./hr the price was £35 5s 9d; no purchase tax was payable. The price of an oil-fired boiler with a rating of 45,000 B.Th.U./hr was £65 and there was no purchase tax. With an exactly equivalent gas-fired boiler the price was £47 5s and in addition there was purchase tax of £23 7s 10d. A similar electrical appliance, within the ratings given, and for normal domestic use, also carried purchase tax of more than £20.

On fuel efficiency grounds alone, gas should be given equitable treatment with the other methods. The Government, under the Clean Air Bill, would subsidize local authorities as to 70 per cent of the cost of providing smokeless domestic fires. Included in this would be gas and electrical units. Therefore the Treasury would pay 70 per cent of the cost of the purchase tax involved. This seemed to be in extraordinary contradistinction to the policy supported by all parties that Parliament should pursue the abatement of air pollution and then tax inequitably the very appliances which made a maximum contribution to the policy of smokeless air. The Beaver Committee had recommended the removal of purchase tax on gas and electric room and water heaters.

In his reply to the debate, Mr. R. A. Butler, the Chancellor of the Exchequer, said that Mr. Nabarro had raised some difficult points about discrimination between the various fuels and he would certainly examine the arguments which he had advanced.

Broken Fluorescent Tubes

Mr. Michael Stewart asked the Secretary of State for the Home Department whether he would draw the attention of the public to the danger of phosphorus poisoning from broken discarded fluorescent lighting tubes and of persons transporting these tubes to the unwisdom of leaving vehicles containing them unattended.

Major Lloyd-George said he understood that these tubes did not contain elemental phosphorus and there was no reason to suggest any special precautions when transporting them.

Supergrid Mileage

Mr. Joynson-Hicks, Parliamentary Secretary, Ministry of Fuel and Power, informed Major Hicks-Beach that the total route mileage so far planned for the proposed 275 kV supergrid was 2,180 miles.

Fumes from Underground Gasification

Replying to Mr. Nabarro, Mr. Joynson-Hicks said the important trials of underground gasification of coal could not be continued except at the risk of some air pollution, but everything was being done to keep it to a minimum. If and when the experiments had been proved economically satisfactory and there was commercial development these waste gases would be utilized and he hoped there would then be no noxious aromas.

Pension Schemes

In reply to Mr. Arthur Palmer, Mr. Joynson-Hicks said that the Electricity Boards were responsible for reviewing pension schemes and suggesting changes but they must seek the Minister of Fuel and Power's approval for any proposed amendments. He had received proposals from the Central Electricity Authority for increasing the pensions of their ex-company pensioners and was prepared to approve some supplementation.

Rejected British Tenders

Mr. Sorensen asked the President of the Board of Trade how many tenders from this country for United States contracts, during the past five years, had proved to be the lowest and according to requirements, but had subsequently been rejected for other reasons; and what was the approximate total value of the orders thus lost.

Mr. Peter Thorneycroft said this information was not available since the Government did not necessarily hear the results of all the tenders for United States contracts.

Mr. Bottomley asked the President of the Board of Trade why he declined to make representations to the United States Government against the addition to the lowest foreign bid of 12 per cent for the purpose of appraising bids.

Mr. Thorneycroft: The new rule adopted by the Department of the Interior is a clarification and an improvement on what has happened before. Previously, a low bid by a foreign firm had little, if any, chance of success if the lowest United States bidder intended to manufacture the plant in an area of substantial unemployment as defined by the Secretary of Labour. In the circumstances it would be inappropriate to make representations to the United States Government against the decision.

Mr. Bottomley said that if we were to have "Trade, not aid" the U.S.A. should be asked to stop putting a percentage increase on British bids.

Mr. Thorneycroft said that if we had an area in this country where the unemployment level was 6 per cent we should try to introduce some form of protection for it. The new arrangement, under which American firms got virtually 12 per cent tariff protection, was better than the system which existed before, when, if there was an area of substantial unemployment, we had no chance whatever of getting a contract.

Mr. Thorneycroft, replying to another question, said that following the passage last summer by the United States Congress of the Trade Agreements Extension Act, the contracting parties to the General Agreement on Tariffs and Trade had agreed to arrange for further multilateral negotiations for the reduction of the general level of tariffs. These negotiations, in which about 25 contracting parties, including Great Britain and the United States, would be taking part, were to open at Geneva on 18th January.

Glasgow Railway Electrification

Mr. Boyd-Carpenter, Minister of Transport, informed Mr. Steele that a proposal to electrify certain suburban railways in and around Glasgow, as suggested by the Inglis Committee, had been approved in principle by the British Transport Commission subject to the conclusion of a satisfactory agreement with the Glasgow Corporation for the co-ordination of transport facilities in the area. Negotiations with the Corporation are proceeding.

Scottish Power

Mr. Woodburn asked the Secretary of State for Scotland whether he would give an assurance that the development of electric power in Scotland from steam and other power would be maintained. He also asked for an assurance that the Government's policy of capital restriction would not apply to provision for electrical development, and that economies in capital expenditure would not be allowed to dislocate the progress of hydro-electric schemes which employed labour in areas where no alternative employment existed.

Mr. J. Stuart said the Government appreciated the importance of the

continued expansion of production of electricity in Scotland and also the value of hydro-electric projects in providing employment. These considerations were being fully borne in mind during the current review of the investment programmes of the Scottish Electricity Boards.

In answer to a question by Mr. Nabarro the Secretary of State for Scotland gave particulars of the schemes which the North of Scotland Hydro-Electric Board has in hand.

He also informed Mr. Nabarro that at the end of October last the Board had spent £117,300,000 on capital account, of which £94,100,000 was for generation and associated main transmission projects. At that date about £53,300,000 was committed in respect of unfinished projects and it was estimated than an additional £9,050,000 would be required to complete them. The aggregate capital cost of projects sanctioned but not yet commenced was estimated at £2,155,000.

Nickel Supplies

Mr. Frederick Lee was told by the President of the Board of Trade that by far the greater part of our supplies of nickel came from Canada. There was a world shortage; some manufacturers were getting less than they could use, and were unable to build up stocks. Manufacturers were buying increasing quantities of nickel from other sources, mainly from New Caledonia, but the amounts obtainable were comparatively small.

Replying to Mr. Mikardo the President of the Board of Trade said that the embargo limit of 60,000 kW on the export of turbo-generators to the Soviet Union and Eastern Europe was fixed on 30th April last. The previous limit was 10,000 kW.

Automation

Mr. Bevins, Parliamentary Secretary, Ministry of Works, told Lt.-Col. Lipton that the report on automation in industry which the Department of Scientific and Industrial Research was preparing would be in the hands of the printers early in the New Year.

A Private Member's Bill introduced by Mr. R. Edwards seeks to provide for the establishment by the President of the Board of Trade of a permanent committee "to inquire into, review and report on the social, educational and economic needs and consequences of the application of automation and electronic devices to British industry and agriculture; and for purposes connected therewith." This committee would have not more than forty or fewer than twenty members representing a variety of bodies, including employers' and employees' organizations, nationalized industries, educational bodies, etc. Among those specified in a schedule to the Bill are the Trades Union Congress, the Federation of British Industries, the Engineering Employers' Federation, the Central Electricity Authority, the Electrical Trades Union, the Department of Scientific and Industrial Research and the Institution of Production Engineers.

Noise Reduction

In the debate on noise, Mr. Ronald Bell said that in the search for practical and early remedies for the scourge of noise there was scope for administrative action. In London, for example, he was told that the remaining trolleybuses were to be scrapped and replaced by diesel buses. "Surely," he said, "we should seek wherever we can to develop electric traction rather than encourage the noisiest and smelliest forms of locomotion."

Blyth Generating Station Bill

The Private Bill Committee of the House of Commons which considered the Blyth Generating Station (Ancillary Powers) Bill, which had been passed by the House of Lords, decided last week to reject that part of the Bill providing for the construction of a pipe-line through which it was proposed that 500,000 tons of ash would be sluiced into the North Sea annually. The disposal of ash by means of barge does not require legislation, but it was pointed out during the proceedings that the cost of the pipe-line system would have been £146,000 as against nearly £2 million for the construction of an ash-barge dock and the provision of barges and bunkers.

Objections to the pipe-line method were made by the Northumberland County Council, the Northumberland Sea Fisheries Committee, the Northumberland and Tyneside River Board, and the Tynemouth, Sunderland, South Shields and Whitley Bay Councils. They claimed that the discharge of such large quantities of ash into the sea at a point 90 yd below the low water mark would cause the beaches to be polluted with ash, and that it would drive away fish by depriving them of their natural food.

The Committee approved the other parts of the Bill, which included the construction of a pipe-line for the disposal of cooling water. During the proceedings it was stated that the proposed method of sluicing ash into the sea by means of a pipe-line would create a precedent in this country.

The Bill will go to the House of Commons for its third reading.

Oil as Fuel

In reply to Mr. Joseph Slater, Mr. Joynson-Hicks said that the first dual-fired generation station was expected to be running on fuel-oil before the end of the year.

Limits to Water Power

In a debate on Commonwealth development in the House of Lords, Lord Tweedsmuir said it was a favourite trick of the after-dinner speaker to talk about "unlimited natural resources" but no material thing could be unlimited. Those countries which were called "backward" were nearly always backward for one reason—lack of sources of power, whether it was oil, coal or electricity. He wondered how many people realized how relatively few undeveloped hydro-electric power resources there were left in the world. Human wants were capable of indefinite expansion. To make pots and pans out of aluminium meant taking a metal which was practically concentrated hydro-electric power. To make one ton of aluminium required as much hydro-electricity as would run a highly electrified house for 12 years. The resources of the world not only had limits, but limits which were not far from being reached.

THE "VICTORIA" LINE

Addressing members of the Metropolitan Section of the Institute of Transport on Monday last, Sir John Elliot, chairman of London Transport, said that, unless a better name could be found, it was proposed to call the projected tube railway from Victoria to Walthamstow the "Victoria" Line. The British Transport Commission was not at present committed to the construction of the line, although a Parliamentary Bill authorizing it was about to become law. It was a project of great magnitude and discussions on financing it were still in progress.

The annual interest charges on the construction costs of £50 million might well be over £2 million; the net traffic receipts would be about £350,000. Some of this would be revenue diverted from other road and rail services, however, and the net result would be an annual loss to London Transport of about £2¼ million. But the receipts in the area as a whole were about £100 million a year and the project had to be viewed as an all-London one.

PRICES OF MATERIALS

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £171 0s 0d
COPPER, H.C. Electro	ton £386 10s 0d
Fire Refined 99·70%	ton £385 0s 0d
Fire Refined 99·50%	ton £384 0s 0d
COPPER Tubes ..	lb 3s 8⅜d
Sheet	ton £457 0s 0d
H.C. wire and strip ..	ton £434 5s 0d
LEAD, English ..	ton £110 15s 0d
Foreign	ton £109 0s 0d
MERCURY	flask £90 0s 0d
TIN, block (English) ..	ton £805 10s 0d
ZINC, G.O.B. Foreign	ton £97 10s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)..	lb 2s 11½d
Sheet	ton £354 10s 0d
Wire	lb 3s 6½d
PHOSPHOR BRONZE Wire	lb 5s 3½d
PLATINUM	oz £32 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 38⅜—3 9d

PERSONAL AND SOCIAL

News of Men and Women of the Industry

As we reported in our issue of 30th September, **Mr. S. F. Steward,** C.B.E., is relinquishing the position of chairman of the South Western Electricity Board at the end of the year to become managing director of Lancashire Dynamo Holdings, Ltd. It is now announced that the Minister of Fuel and Power has appointed **Mr. A. N. Irens,** M.I.E.E., to succeed Mr. Steward as chairman of the South Western Board.

Mr. A. N. Irens

Mr. Irens, who is already a member of the Board, is chief electrical and general services engineer to the Bristol Aeroplane Co. He was born in India in 1911 and after education at Blundell's School, Tiverton, went to Faraday House, receiving training with Fielding & Platt, Ltd., and the Metropolitan-Vickers Electrical Co., Ltd. He joined the General Electric Co., Ltd., in 1933 and later became sales engineer (central stations). Mr. Irens' connection with the Bristol Aeroplane Co. began in 1929 when he was appointed assistant electrical engineer. In 1943 he became chief electrical engineer and subsequently chief electrical and general services engineer to the company. In recent years he has also conducted a consulting practice with an office in Belfast.

Mr. Irens has been a part-time member of the South Western Board since its establishment in 1948; he has served as chairman of the I.E.E. Utilization Section and was chairman of the Western Centre for 1954-55.

Mr. Harold Midgley, the deputy chairman of the South Western Board, has been advised by his doctors that he should relinquish his responsibilities as soon as possible. While he acquiesces in this, he feels that he should remain with the Board during the change of chairmen. He will take charge of the Board during January and February and will continue as deputy chairman for a short period after that.

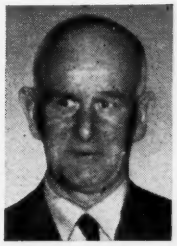
Mr. J. D. Peattie, B.Sc., F.C.G.I., M.I.E.E., deputy chief engineer (generation) of the Central Electricity Authority, has been appointed acting chief engineer of the Authority in succession to **Mr. V. A. Pask,** C.B.E., M.I.E.E., M.I.Mech.E., who, as reported in our issue of 23rd September, is retiring at the end of the year.

Mr. Peattie was educated at Morgan Academy, Dundee, and St. Andrews and London Universities. Later he was engaged on high voltage d.c. research for three years with Siemens-Schuckertwerke, Berlin. After service with the Royal Naval Division and the Royal Engineers during the first world war, he gained experience in heavy plant, factory and mains installations, first with Metropolitan-Vickers and then with Edmiston Brown, Glasgow. In 1928 he joined the Manchester Corporation Electricity Department and was responsible for the change-over from d.c. to a.c. of the l.v. distribution system.

Mr. Peattie joined the Central Electricity Board in 1929 as operation engineer, headquarters. He became deputy chief engineer in 1944, and has held the same position with the Central Electricity Authority, for transmission from 1947 to 1949 and for generation to date.

Mr. Peattie has been responsible for much pioneering work in connection

Mr. J. D. Peattie



Mr. W. B. Noddings

with the forward planning of extensions to the country's generating capacity and also in connection with the control of the output from all public stations and the grid. He has written several major papers on aspects of the supply industry, and that on "The British Grid System in War-Time" in collaboration with Sir John Hacking, in 1947, gained him the Llewellyn B. Atkinson Premium of the I.E.E. He is a member of the Council of the Institution and during the 1954-55 session was chairman of the Supply Section. In 1953 he was elected a Fellow of the City and Guilds of London Institute.

Mr. Peattie was a member of the Clow Committee on peak load problems, the Industrial Coal Consumers' Council, the Inland Water Service and the Comité de Direction of UNIPEDE. He has been greatly interested in particle mechanics and is chairman of an advisory committee dealing with the subject for the British Coal Utilization Research Association and other interested bodies.

Mr. W. B. Noddings, M.Eng., M.I.E.E., a deputy commercial manager of the Central Electricity Authority, has been appointed head of the Commercial Department of the Authority. He succeeds **Mr. E. R. Wilkinson,** M.I.E.E., M.I.Mech.E., who, as recently announced, is relinquishing his post at the end of the year to join the boards of Power Securities Corporation, Ltd., and Balfour Beatty & Co., Ltd.

Mr. Noddings was educated at Liverpool University where, in 1923, he gained a B.Eng. degree with first-class honours. After early training with the Metropolitan-Vickers Electrical Co., Ltd., he became an assistant engineer with Messrs. Merz & McLellan. He joined the Central Electricity Board in 1928 as an assistant engineer and was subsequently appointed assistant commercial manager. In 1946 he became deputy commercial manager of the Board, a post he held until the nationalization of the electricity supply industry in 1948 when he took up his present position with the Authority.

Mr. J. M. W. McBride, B.Sc., A.M.I.E.E., has been appointed to a lectureship in light electrical engineering at Queen's University, Belfast, and **Mr. D. S. McIlhagger,** M.Sc., Ph.D., A.M.I.E.E., to a lectureship in electrical engineering.

It is announced by E.M.I. Suppliers, Ltd., that **Mr. Kenneth Moore** has now been appointed manager of its trade division in succession to **Mr. N. LeGassicke,** who has left the company to take up an appointment in the United States. Mr. Moore, who was educated at the City of London School, has been an executive with the company for some time past. From 1932 to 1941 he was connected with the electric lamp industry. Since 1945 he has devoted his activities to the promotion of sales in world markets in the electrical and engineering fields, having served as sales director on the board of a large engineering concern, and before taking up his present appointment was the export manager of Electronic Tubes, Ltd. — an associated company of Electric & Musical Industries, Ltd.

Mr. Max H. Moss, who has been

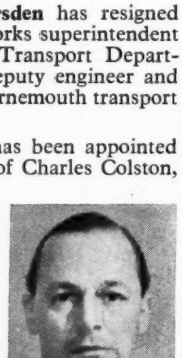
Mr. K. Moore

Mr. M. H. Moss

in the trade division for a number of years, becomes assistant manager. Before he joined that division he was in the Export Department of a radio manufacturing company.

Mr. T. M. Marsden has resigned from his post as works superintendent of South Shields Transport Department to become deputy engineer and manager of the Bournemouth transport undertaking.

Mr. J. P. Ford has been appointed managing director of Charles Colston, Ltd. **Sir Charles Colston** is chairman of the new company. Mr. Ford joined the company in October last from the Brush Group, where he spent seven years and was managing director of the Group's export companies. He was also a director of Associated British Oil Engines (Marine), Ltd., and Brush Aboe (Ireland), Ltd. Mr. Ford gained his early engineering experience with the Coventry Gauge & Tool Co., Ltd. After the war he was appointed general manager of British Engineers Small Tools & Equipment Co., Ltd., and during the same period he was appointed general manager of Scientific Exports (Great Britain), Ltd. He is a member of the F.B.I. and other overseas trade committees, and was formerly a member of the Council of the British Internal Combustion Engine Manufacturers' Association and chairman of its Export Committee. He is also chairman of the Institute of Export and Council member of the London Chamber of Commerce.



Mr. J. P. Ford

Following the recent formation of Square D, Ltd., specialists in electrical control gear and switchgear, it is announced that **Mr. H. Dale Langley,** B.Sc., has been appointed technical manager in the United Kingdom, with ultimate responsibility for technical liaison with British manufacturers. The new company is an associate of the Square D Co. of America. Mr. Langley has been associated with the American company since 1950. He has had considerable experience in the steel and electrical motor industries in the United States.

Mr. H. D. Langley

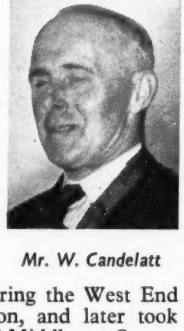
Sir Cyril Hinshelwood, Dr. Lee's Professor of Chemistry in the University of Oxford and Fellow of Exeter College, Oxford, has been elected president of the Royal Society. Among the members of Council are **Sir Claude Gibb,** C.B.E., chairman and managing director, C. A. Parsons & Co., Ltd.; **Professor N. F. Mott,** Cavendish Professor of Experimental Physics, University of Cambridge; and **Dr. B. F. J. Schonland,** C.B.E., deputy director, Atomic Energy Research Establishment.

Mr. F. D. Newcombe, who has been chairman of the Exeter Branch of the Electrical Industries Benevolent Association from its inception, has expressed his wish to retire from that office. **Mr. Harold Peters,** hon. secretary, has been appointed to take his place. **Mr. W. H. Mortimer** has been appointed hon. secretary and **Mr. W. A. Dobson** hon. treasurer of the Branch.

Birlec, Ltd., the furnace manufacturing company in the A.E.I. Group, announces that **Mr. P. F. Hancock,** research manager, **Mr. A. E. Pickles,** manager of the induction heating division, and **Mr. J. F. Ross,** works manager, have been appointed directors of the company.

Mr. R. H. West, formerly with Vokes, Ltd., has joined Creators, Ltd., plastics designers and manufacturers, of Woking, Surrey, as chief buyer.

Mr. W. Candelatt, who, as we reported in our last issue, has been elected national chairman of the Electrical Trades' Commercial Travellers' Association for 1955-56, is Yorkshire born, but has been domiciled in the south since 1919. He joined the Hotpoint Electric Appliance Co., Ltd., in 1928 as a representative covering the West End and City of London, and later took over the counties of Middlesex, Surrey and Kent. He became a member of the E.T.C.T.A. in 1945, was appointed secretary to the Council in 1950, and was elected vice-chairman last year.

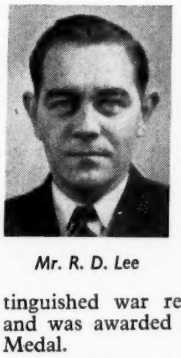


Mr. W. Candelatt

Mr. G. R. Blakely, B.Sc.(Eng.), M.I.C.E., M.I.Mech.E., M.I.Prod.E., has been appointed to the board of G. A. Harvey & Co. (London), Ltd., as works director. Mr. Blakely joined the company in 1952 as general works manager.

Mr. J. H. C. Dalziel has been appointed manager of the Karachi depot of the Marconi International Marine Communication Co., Ltd., in succession to **Mr. T. Moriarty,** who is returning to the United Kingdom for leave before reappointment, having completed his tour of duty in Pakistan. Mr. Moriarty has been in charge of the Karachi depot since it was established in 1949.

The British Central Electrical Co., Ltd., announces that **Mr. R. D. Lee** has joined the company as manager of their Sales and Plant Departments. Mr. Lee has spent twenty-one years in the electrical industry, and served his apprenticeship with Edmundsons Electricity Corporation, Ltd. He had a distinguished war record in the Navy and was awarded the British Empire Medal.



Mr. R. D. Lee

The annual dinner of the **Derby Electrical Society** was held recently when Mr. L. M. McDonald, president of the Derby Society of Engineers, proposed the toast of the Electrical Society. He said that it was difficult to keep in step with modern times and remain fully informed of the development which was proceeding with ever-increasing momentum. Mentioning the problem of fuel supplies, Mr. McDonald referred to the rapid rate of increase in electricity consumption and the erection of power stations to meet the demand. In the past insufficient thought had been given to the movement of materials through the factories, and something must now be done about it. All this would involve a very considerable increase in the already extensive use of electronics, necessitating the training of new types of skilled labour and technicians; they must also bear in mind the strain already placed upon the teaching profession at colleges and universities. Mr. B. J. Williams (chairman), in reply, said that it was impossible to read all the literature on present-day subjects, and therefore it was essential that such societies should exist to keep members informed of what was happening in the many spheres of electrical engineering.

The North of Scotland Hydro-Electric Board has made two new appointments to fill the vacancy of chief hydraulic and civil engineer previously held by **Mr. A. A. Fulton,** now general manager of the Board. **Mr. L. H. Dickerson,** M.I.C.E., A.M.I.W.E., has been appointed chief civil engineer and **Mr. P. L. Aitken,** B.Sc., A.M.I.C.E., chief hydraulic engineer.

Mr. Dickerson was employed by Balfour Beatty & Co., Ltd., on the early investigations of the Grampian hydro-electric scheme before serving as assistant engineer on the first stage of the Lochaber scheme. He was later engaged on the design and construction of all sections of the Grampian works and on completion continued as engineer in charge of maintenance until joining the North of Scotland Board in 1948. Lately, he has been chief assistant to **Mr. Fulton.**

Mr. Aitken received his training under the city engineer of Dundee, before taking up an appointment with the borough engineer of Derby. He joined the staff of the Board in 1946.

At the annual general meeting of the Junior Institution of Engineers held on 25th November **Mr. J. C. Y. Baker,** A.R.Ae.S., was elected chairman for the ensuing year.

Mr. A. F. Holt, A.M.I.C.E., borough engineer of Croydon, is taking over the responsibility for street lighting on behalf of the Corporation on 1st January.

Mr. R. L. Kay, A.M.I.Mech.E., A.M.I.E.E., senior assistant and deputy to the steam testing engineer of the North Eastern Division of the Central Electricity Authority, has been appointed steam testing engineer of the Division in succession to Mr. P. G. Lloyd, who has retired.

Mr. Kay, after early training with the Metropolitan-Vickers Electrical Co., Ltd., and the Edinburgh Corporation Electricity Department, joined the Anti-Submarine Branch of the Admiralty in 1939 as an experimental assistant. He served successively as experimental officer of that branch, at the Anti-Submarine Experimental Establishment, and at the Torpedo Experimental Establishment, Greenock. In 1946 he was appointed scientific officer in the Royal Naval Scientific Service, becoming senior scientific officer six months later. He joined the North Eastern Division of the Authority in 1950.

British Insulated Callender's Cables, Ltd., announces the appointment of

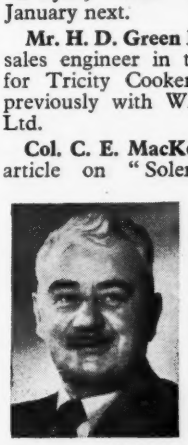
Mr. G. W. Wheaton

Mr. G. W. Wheaton, B.Sc., as branch manager in Middlesbrough in succession to **Mr. R. N. Crawford,** who is retiring. The appointment takes effect from 1st January. Mr. Wheaton was educated at Waverley Grammar School, Birmingham, King's School, Canterbury, and Birmingham Central Technical College. He studied metallurgical aspects of public construction work with Mr. A. E. Tucker, F.I.C., and later was employed by H. W. Lindop & Sons, Walsall, and the B.S.A. Co., Birmingham. He served in the Submarine Service in the last war and on demobilization in 1946 he joined British Insulated Callender's Cables, Ltd., and was assistant superintendent of the Wire Drawing Department at the Prescot works until 1954 when he joined the Home Sales Department and was appointed to the Middlesbrough sales office.

Mr. E. B. Coughtrie has resigned from the Admiralty electrical staff (Scottish area) and is joining the staff of A. Reyrolle & Co., Ltd., Hebburn-on-Tyne, with effect from 31st January next.

Mr. H. D. Green has been appointed sales engineer in the Midlands area for Tricity Cookers, Ltd. He was previously with Wilkins & Mitchell, Ltd.

Col. C. E. MacKellar, author of the article on "Solenoids," which is published in this issue, is a director of Westool, Ltd. He served in Gallipoli and Palestine in the 1914-18 war and in Malaya in the last war, when he was a prisoner of war in Japanese hands for three and a half years at the time of the building of the notorious Bangkok-Moulmein railway.



Col. C. E. MacKellar

The necessity for a high standard of technical training for apprentices in the electrical industry was emphasized by speakers at the annual dinner of the **Ipswich and District Electrical Association** on 2nd December. The toast of the Association was proposed by Mr. H. A. T. Simmonds, principal of Trent Park Training College, who said that his opinion, as a layman, was that electrical equipment to-day changed too quickly in design, so that an article bought in the shops soon became outmoded. Mr. S. Hardy (chairman) responded. Proposing the toast of "The Electrical Industry," Mr. E. G. Couzens, technical director of Bexford, Ltd., suggested that too much public attention was focused on the arts and too little on science at a time when technical training was an urgent national necessity. Parents, he said, should ask themselves whether it was not their duty to send their children "into the front ranks of the technicians" for the competitive battle with America and Russia. The response was made by the president, Mr. C. T. Melling. "The Guests" was proposed by the vice-chairman, Mr. H. P. Thompson, and the Mayor of Ipswich, Ald. C. G. Rushen, and Mr. H. Hawkins, chief engineer of B.X. Plastics, Ltd. (deputizing for Lieut.-Col. C. M. Glover), replied.

Mr. C. H. Bradbury, at present technical director of Petters, Ltd., is joining the Simms group of companies on 1st January. Mr. Bradbury's early education and training were gained at Lincoln School and Lincoln Technical College and later as an apprentice with Ruston & Hornsby, Ltd. In 1938 he was appointed chief research engineer with that company, a position he held until joining Petters, Ltd., Staines, as chief engineer in 1949. In 1951 he was appointed to the board of Petters as technical director. Mr. Bradbury is a member of the Institutions of Civil, Mechanical and Marine Engineers.

Mr. S. Jefferson, B.Sc., A.C.G.I., whose article on "Electrical Applications of Radio-active Isotopes" appears in this issue, was educated at Bolton School and Imperial College, London. He has carried out research work with Siemens Bros. & Co., Ltd., Murphy Radio, Ltd., and E.M.I. Research Laboratories, Ltd. Mr. Jefferson worked on radar from 1936 to 1947 in the Bawdsey Research Station and Telecommunications Research Establishment at Dundee, Swanage and Malvern. He formed the Industrial Electronics Group at T.R.E. Malvern in 1948 and he joined the Industrial Applications Group, Isotope Division, at the Atomic Energy Research Establishment, Harwell, in 1951.

Mr. S. Jefferson

On 1st December the **J. & P. Staff Association** (Johnson & Phillips, Ltd.) held a dinner, dance and cabaret at the Connaught Rooms, London. Mr.

At the annual dinner of Ipswich and District Electrical Association. (Left to right): Mr. H. A. T. Simmonds (principal, Trent Park Training College); the Mayor of Ipswich (Ald. C. G. Rushen); Mr. S. Hardy (chairman); Mr. C. T. Melling (president); the Bishop of St. Edmundsbury and Ipswich (Dr. A. H. Morris); Mr. H. Hawkins (chief engineer, B.X. Plastics, Ltd.); and Mr. E. G. Couzens (technical director, Bexford, Ltd.)

G. Leslie Wates, J.P., Companion I.E.E., chairman and joint managing director of the company, proposed the toast of the Association. He preceded his remarks by paying a tribute to the late Mr. W. F. Smith who, he said, would always be remembered for his services as chairman of the Association and also in connection with so many other social activities of the company over the past fifty years. Mr. C. E. Collar, A.M.I.E.E., in responding, reminded his listeners that during next year Mr. Wates would be celebrating his jubilee as chairman of the company. He concluded by emphasizing the happy relations existing between staff and management, the great future for all employed in the electrical industry, and the big part played by J. & P. in the export market. Finally he read cablegrams from J. & P. factories and branches overseas.

The annual dinner of the Birmingham Branch of the **Electrical Contractors' Association** was held on 30th November. Mr. S. T. Walker, president of the Birmingham and Five Counties' Architectural Association, proposed the toast of the Electrical Contractors' Association, to which Councillor H. F. Truman, chairman of the Midland Sectional Board, responded. Mr. Walter S. Lewis, chairman of the Midlands Electricity Board, replying to the toast to the guests, proposed by Mr. B. Harris, the Branch chairman, said that the 10 per cent cut in the M.E.B. capital expenditure figure of £6,300,000 would probably entail slight delays in rural development schemes.

At the St. Pancras Town Hall on 29th November the Music Society of the **London Electricity Sports and Social Association** presented another of its choral and orchestral concerts. This time the choral element was more prominent than usual, largely because a number of Christmas carols were included. The main items were Gershwin's "Rhapsody in Blue," with Arthur Whitehead at the piano, and Elgar's "From the Bavarian Highlands." Also in the programme were the overture to "Orpheus in the Underworld" (Offenbach), Eric Coates's "London Everyday" suite and Lehar's "Gold and Silver" waltz. The standard of both the orchestra, under Leslie Atkins, and the choir, conducted by Douglas Sharpe, remains very good. Norman Fearing was the solo baritone for the carols. The audience included Mr. H. J. Randall, chairman of the London Electricity Board and president of the Association, and Mr. E. A. Mills, member of the Board.

The Glasgow and District Branch of the **Electrical Association for Women** was the first branch to celebrate its 30th birthday. At the anniversary dinner held last month in the St. Enoch's Hotel, Lady MacColl, branch president, took the chair. Lord Strathclyde, Minister of State for Scotland, proposed the toast of the branch, to which Mrs. R. G. McInnes, branch chairman, replied. The toast of "Electricity" was given by Mr. G. G. Browning and the response was made by Mr. J. S. Pickles, chairman, South of Scotland Electricity Board. Miss Norah Balls, chairman of the Association, responded to the toast of the guests given by Mrs. M. B. Ash, immediate past-chairman, Glasgow Branch.

OBITUARY

Mr. Francis Heron Rogers, M.I.Mech.E., etc., a director of the British Vacuum Cleaner & Engineering Co., Ltd., died on 27th November. Mr. Rogers joined the board in 1931 and was also a director of Stream Line Filters and the Oliver Typewriter Manufacturing Co. He was past-president of the Institution of Chemical Engineers.

Mr. N. Blackett.—The death has occurred at Crook (Co. Durham) of Mr. Norman Blackett, who retired some time ago because of ill-health from his post as Crook district engineer for the North-Eastern Electricity Board. He was fifty-eight, and joined the former Newcastle Electric Supply Co., Ltd., after the 1914-18 war.

Mr. L. W. Hare.—The death occurred on 4th December of Mr. Leslie W. Hare, of the Birmingham office of Lancashire Dynamo; he was in his sixtieth year. Mr. Hare was educated at Brentwood Grammar School and served an apprenticeship with Crompton & Co., Chelmsford. After being with the Kohler Lighting Co. for some years he joined Lancashire Dynamo & Crypto and had been at the Birmingham office for twenty-six years. He leaves a widow and a son.

Mr. W. Ward.—The death occurred on 28th November of Mr. Walter Ward, who until he retired in 1954 was for many years in charge of the British Thomson-Houston Co.'s staff restaurant at Rugby. In later years he was also in charge of the Stationery Department.

WILLS

Mr. J. J. Conlan, editor of the *BEAMA Journal* and head of the publicity and statistical department of the British Electrical and Allied Manufacturers' Association, who died on 6th July last, intestate, left £3,800 gross (£3,640 net).

Major S. J. Thompson, former governing director of John Thompson, Ltd., Wolverhampton, who died on 30th April last, left £156,144 gross (£140,712 net).

Mr. F. Rooney, formerly managing director of the Bengal Telephone Corporation, and a director of the Oriental Telephone and Electric Co., Ltd., who died on 6th September, left £24,722 gross (£24,638 net).

Mr. H. G. Faull, former local director with Thomas W. Ward, Ltd., Sheffield, who died on 22nd August, left £5,474 gross (£3,828 net).

Mr. W. Cannon, senior director of T. B. Morley & Co., Ltd., Hull, who died on 5th April last, left £14,223 gross (£13,937 net).

PRODUCTION EXHIBITION

Work is now proceeding on the organization of the Production Exhibition and Conference, 1956, which will be held in the Grand Hall, Olympia, London, from 23rd to 31st May. The conference, organized by the Institution of Production Engineers, which is to run concurrently with the exhibition, will develop the theme "Investing in Success," and will explore the forecast of the Chancellor of the Exchequer that the standard of living can be doubled in 25 years. The subjects to be covered which link the conference with exhibits include automation, research, atomic energy, fuel utilization, factory design, quality control and inspection, designing for production, simplification and standardization, work study, materials handling, utilization of resources, education and training, and human relations in industry.

The president of the Institution, Sir Leonard Lord, K.B.E., is to be president of the exhibition and conference, and the programme arrangements are being made by an Advisory Committee of the Institution, with representatives of other organizations. The committee includes Sir Walter Puckey (chairman), Mr. B. H. Dyson (Hoover, Ltd.), Mr. T. Fraser, C.B.E. (International Refrigeration, Ltd.), Mr. H. T. Jones (Simmonds Aerocessories, Ltd.), Mr. J. Loxham (Sigma Instrument Co., Ltd.), Mr. R. Telford (Marconi's Wireless Telegraph Co., Ltd.), Mr. H. A. R. Binney (British Standards Institution) and Dr. Alexander King (Department of Scientific and Industrial Research). All inquiries regarding the exhibition should be made to Andry Montgomery, Ltd., 32, Millbank, London, S.W.1, and all conference inquiries to the Institution of Production Engineers, 10, Chesterfield Street, London, W.1.

ST. DUNSTAN'S

The great work carried out by St. Dunstan's in the rehabilitation and training of men and women blinded in the two world wars is, of course, well known. The report for the year ended 31st March last (the fortieth) once again describes and illustrates some of the work which is being done to enable the blind to play their part in the life of the community. It thanks all those who have helped by voluntary service, and those throughout Britain and the Commonwealth who by gifts, large and small, make it possible for the work to go on.

E.D.A. ANNUAL LUNCHEON

The annual luncheon of the British Electrical Development Association will take place at the Savoy Hotel, London, on Tuesday, 24th April next. Immediately after the luncheon the annual general meeting of the Association will be held.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Load-Curve Analysis

THE article by Mr. P. Schiller in the *Electrical Review* of 2nd December refers to the application of multiple regression using kWh data for load-curve analysis but fails to mention the origin of the method which he describes.

It is pertinent to point out that there was a lag of about forty years in the application of multiple regression to problems in the electricity supply industry after it was used by Karl Pearson. Mr. Schiller recalls that he and Mr. N. L. Johnson applied multiple regression to estimate the influence of weather on the demand of a system in 1945. The extension of this method of analysis to estimate the demand of the principal consumer classes on large systems, as required for costing supplies to individual consumer classes and other purposes, was held up for several years because it was not apparent that the kind of data required was readily available from existing records.

When I was engaged on research for the South Western Electricity Board into the cost of supplying electricity I applied, so far as I am aware for the first time, multiple regression, using kWh sales and the collective load of large systems to estimate the demand of each of the principal consumer classes. These results were widely circulated within the industry in August, 1952, and this method was subsequently taken up in an enthusiastic manner by Mr. Schiller.

London, W.14. F. H. DENNIS.

Some Export Facts

WE were interested to read the leading article in your issue of 25th November about electrical exports, but feel that these constant statements by Government officials and also other persons in the electrical trade are becoming rather boring.

For instance, it is stated that certain Continental competition is stimulated by unfair methods. These " unfair methods " are probably supposed to be export subsidies, but the export subsidies of pre-war Germany no longer continue except that forceful encouragement is given by certain Continental Governments to the export trade to make it worth their while to do their utmost to achieve exports. For instance, certain tax credits are given for direct or indirect export deliveries. Special purchase rates are allowed by certain manufacturers, with Government encouragement, for raw materials to be used for export contracts, and in fact other tangible encouragement is given to exporters and exporting manufacturers.

The second point mentioned is the uncertainty of payment in certain overseas markets. It was stated that as good a protection was available through the Export Credits Guarantee Department as anywhere in the world. Surely such a statement is not made based on actual experience, and before such boasts are put into official speeches, it would be advisable to make sure what other Governments are doing to assist exporters and exporting manufacturers of their respective countries in comparison with what can be achieved in this country through the Export Credits Guarantee Department.

Finally, high prices are mentioned, and we feel it is about time that somebody asked who, in fact, is responsible for the high prices. While prices in the electrical trade in this country are rising steadily, increasing cost of manufacture, competing countries, especially on the Continent, are reducing their prices. Quite obviously if autumn Budgets increase the cost of living even by a fraction only, the manufacturers when faced with demands for wage increases cannot help granting them, which in turn will increase sale prices, and if on top of all this, the home market is being strangled, the export prices must of necessity, be increased as well. The increase in prices is not only caused by the increase in wages, but also mainly by the constant increase in cost of fuel, transport, etc., all by nationalized industries.

In point of fact therefore, the future export position of finished electrical goods is, in our opinion, not very promising, especially also considering the amount of manufacture in most overseas markets, operation of import licensing restrictions, protective duties, etc., which make the position more difficult every week.

London, S.E.1. W. KUPFER,
Director,
W. & E. Kupfer, Ltd.

Faraday Lecturer's Acknowledgment

TO be successful any undertaking to-day must depend upon the united effort of a team of people. This is none the less true of the Faraday Lecture organized each year by the Institution of Electrical Engineers and I would like to take this opportunity to thank the following manufacturers who have helped me with equipment for the various demonstrations:—Anderson, Boyes & Co., Ltd., Automatic Telephone & Electric Co., Ltd., Baldwin & Francis, Ltd., British Thomson-Houston Co., Ltd., Clifford & Snell, Ltd., Dowty Mining Equipment, Ltd., General Electric Co., Ltd., Igranic Electric Co., Ltd., Imperial Chemical Industries, Ltd. (Nobel Division), E. N. Mackley & Co., Ltd., Metopolitan-Vickers Electrical Co., Ltd., Nash & Thompson, Ltd., Oldham & Son, Ltd., A. Reyrolle & Co., Ltd., Ernest Turner Electrical Instruments, Ltd., Victor Products (Wallsend), Ltd., and Wolf Safety Lamp Co., Ltd. There are many firms missing from this list who would have helped me if I had asked them but owing to the limitations of time and space imposed by the Lecture and the halls, a selection was inescapable.

When we think of Michael Faraday in 1844 descending Haswell Colliery with his colleague Lyell the famous geologist, suspended in a basket on the end of a rope, lowered in all probability by a horse gin, to investigate an explosion caused by a Davy lamp carried, perhaps, by a ten- or twelve-year-old boy, we can take pride in the technical and social progress which we have made since that date.

The achievement and inspiration of Faraday have enabled the electrical engineer, backed up by a progressive manufacturing industry, to develop and make mining electrical equipment which gives us a greater overall degree of safety and reliability in our mines than is to be found in any other country in the world.

National Coal Board,
London, S.W.1. B. L. METCALF.

Thermistors and Amplitude Modulation

Properties and Vector Notation

TWO papers were presented by Dr. C. J. N. Candy (S. Smith & Sons, formerly at the University of North Wales) at a meeting of the Measurements Section of the Institution of Electrical Engineers on 29th November. The first concerned the properties of thermistors (semiconductors with large negative-temperature coefficients) as circuit elements in very-low-frequency systems.

The paper showed that a typical thermistor (Standard Telephones & Cables) consisted of a small bead fused to two fine terminal wires and mounted in an evacuated glass capsule. If the thermally sensitive resistor were polarized from a steady source of current greater than the signal current, the harmonic distortion would be negligible and the phase shift much increased. By using an equivalent impedance for the resistor having a semi-circular vector locus, all the parameters could be easily determined. The large time-constant associated with thermistor phase-shift networks made them suitable for stabilizing low-frequency automatic control systems, such as the steering of ships and aircraft, where small size was an advantage. Other uses included process controls, temperature control of ovens and stabilization of supply voltages.

In a second paper Dr. Candy described a vector notation for amplitude-modulated signals, which enabled vector expressions to be derived for impedances, admittances and transfer ratios of electrical circuits. These expressions in turn operated directly on the vector for the amplitude-modulated voltages and currents to give the vectors for the independent variables in the circuit, enabling direct calculation of output of a demodulator for any general input to the circuit. A complementary operational method was given for determining response of circuits to non-sinusoidal amplitude-modulated signals.

DISCUSSION

The discussion was opened by Dr. D. Morris (University College of North Wales), who hoped for a more complete description of the oscillators and the parallel T network soon because of the interesting dependence of the controls. Dr. Candy's analogy between thermistor circuits and the conventional RCL circuits was not exact. The capacitor and inductor could not be combined to form a conventional LC circuit. Nevertheless, the performance of resonant circuits, such as the parallel T circuit, could be described in terms of a quality factor Q, and he asked whether Q values of less than half could be realized.

Dr. J. H. Westcott (Imperial College) thought that, while the practical forms of phase-shift current described would operate, more work on them was necessary. The new method gave a needed extra degree of freedom, particularly in a.c. modulated signals.

Mr. P. P. Eckersley (Telephone Manufacturing Co.) pointed out that a difficulty in certain applications was possible variations of ambient temperature over a wide range in commercial equipment, which would upset the results by as much as 12 dB. The thermistor could be put in the feedback of an RC oscillator to stabilize the output markedly. One ended with a very delicate thermometer measured by frequency. If the window was open, the frequency shifted! The whole method described had many applications. One was for testing automatic gain control over long circuits where hunting might arise. The thermistor's sensitivity and elegance should be stressed.

Mr. F. C. Widdis (Northampton Polytechnic) agreed that the most interesting part of the paper was the fields it opened up for investigation in universities. It contributed usefully to the difficult problem of trying to get along with one's device in a usable form. Results must be reproducible and indicate whether ageing was present, about which there seemed to be little information. The reproducibility of the characteristics of the thermistor was extraordinary.

Mr. H. V. Harley (Weymouth) asked for more information about the definable properties of the thermistor that were similar to those of passive and reactive networks. He inquired whether one could design conventional oscillators for a low frequency, the main oscillator working at a frequency higher than that due to the thermistor. The pulling of the three-phase modulating system might be on the thermistor so that one could simulate magslip for testing magslip circuits over a wide range of frequencies, which at present required pull and disc gearing or some other form of motor-driven magslip.

Mr. F. J. Hyde (Radio Research Station, Slough) commented on the derivative of the analytical form of the impedance. Dr. Candy, he said, had drawn attention to an approximation in equation (8). This amounted to a seemingly unjustifiable ignoring of the terms involving delta R, which was itself a cyclical varying quantity and was similar to the signal current. Account must be taken of the phase-shift between the two.

Mr. T. Ritson (King's College, Newcastle-upon-Tyne) commented on the extraordinary versatility of the thermistor in Dr. Candy's circuits. The normal method of stabilizing a carrier system was presumably to use a notch filter into which the error signal was fed. There were two main limitations to this. First, the carrier frequency had to be kept fairly constant within a few per cent. Secondly, the network was a closed tolerance network requiring accurate and stable components.

It was desired to reduce the thermal capacity of the element, with due attention to the leads, and also to increase the dissipation constant. It might be liquid cooled, perhaps. By this means thermistors could be made with satisfactory short time-constants, which would be useful for stabilizing carrier systems of the kind described.

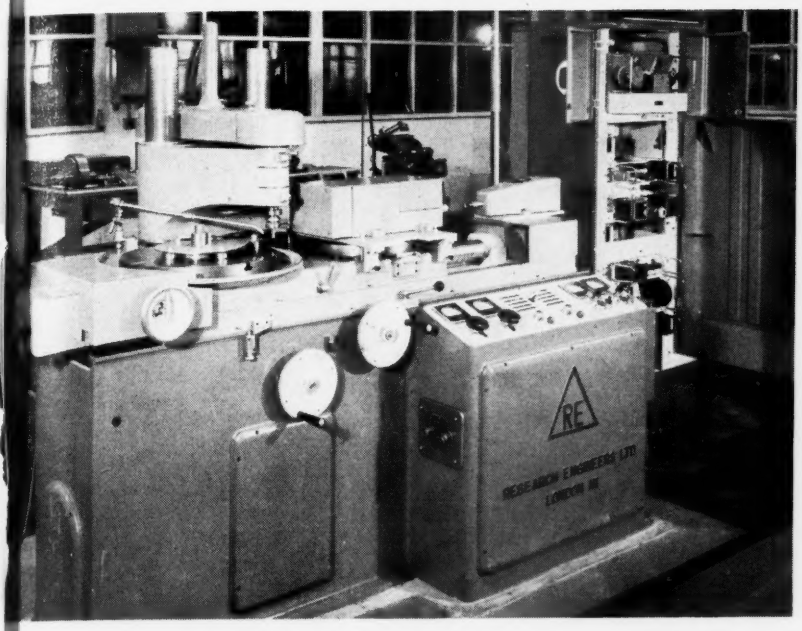
Professor A. Tustin (Imperial College of Science) referred to earlier experiments he himself had carried out in the same field which were, however, of wider application as applied to servos. He was then concerned with stabilizing servos in terms of a simple feedback and was looking for something that would be delayed by a certain time constant. Whereas he had thought in terms of indirect heating, Dr. Candy had dealt with a thermistor that was almost completely self-heated.

Safety in Chemical Laboratories

A SECOND edition of the booklet "Safety Measures in Chemical Laboratories" has been published by H.M. Stationery Office, price 1s 6d. The information covers general laboratory operations, fire risks, electrical hazards, dermatitis and the dangers of poisons and gases. Where appropriate, methods of treatment are given. The present edition includes many amendments suggested by readers of the first edition.

Automatic Milling Machines

FIRST EXAMPLE OF AUTOMATION APPLIED TO MACHINE TOOL CONTROL



Copy-miller adapted for completely automatic operation

WHEN we visited Norwich last week we had the opportunity of inspecting the first fully developed and practical automatic numerical control equipment applied to a machine tool engaged in the regular production of cams. The machine we saw was an electronically controlled milling machine installed at the works of Laurence, Scott & Electromotors, Ltd. This machine is based on a copy-miller made by Research Engineers, Ltd., for the extremely precise copying of two-dimensional cams and it has been modified for fully automatic electronic control by Electric & Musical Industries, Ltd.

The system of control developed by E.M.I. is of a universal nature and it has been successfully applied to various other machine tools. It is believed that the present machine constitutes the first example of automation applied to machine tool control, either in this country or in the United States, which has travelled outside the development laboratory and been installed in the workshop of an independent user.

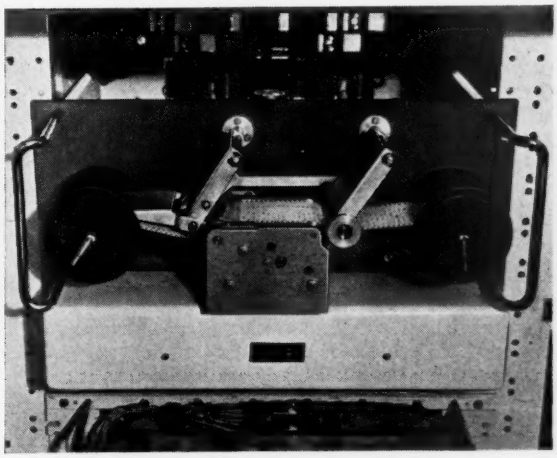
The word " automation " was originally coined in the United States to describe those forms of automatic control by means of which some logical operation is performed as a result of data presented to the equipment. However, the word has been so debased by misuse that one hesitates to use it in its correct sense, but the E.M.I. system of control is a true example of automation. In this system design data in the form of a table, giving the dimensions of the part required as a series of specific points, are presented to the control unit which deduces what movements should be made by the cutting tool and work table to produce the correct profile, and passes appropriate instructions to servo-motors controlling the respective feeds of the machine.

The normal copy-miller can copy a master quickly and cheaply but when a new master is required it must be made by hand which is a slow and expensive process, particularly when a high degree of accuracy is required. This long delay is highly undesirable in development programmes where the work of whole teams of engineers may be held up pending the production of parts to a new design. With an electronically controlled machine of the type installed at Norwich, new parts can be produced as quickly and cheaply as copies can be produced on a copying machine; immediately a design has been completed the part can be produced without the need for a master. All parts are made to the same high degree of accuracy, without the inevitable slight loss of precision which occurs when copying.

As soon as a design has been decided upon a table of dimensions can be prepared and in the case of a cam this would be expressed as radii every so many degrees around the part involved. In fact, it is normal drawing office procedure for such a table to be incorporated in the drawing for a cam. The machine concerned in the present installation has a rotating work table so the dimensions are expressed in polar co-ordinates. Other machines to which the E.M.I. system of control can be applied work in Cartesian co-ordinates.

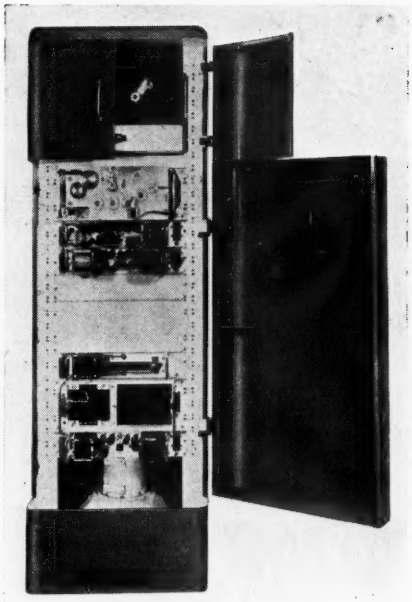
As soon as the table of dimensions is ready it is typed

Close-up of the tape reader in the control cubicle



by an ordinary typist on a machine which records the figures in binary form as perforations in a celluloid tape, in which form they are readily assimilable by a control unit. The machine also records them in normal type form for checking and record purposes. The perforated tape is then run through the " reading head " of the control unit which transfers the data to the information store of the computer incorporated in the control system. In the Norwich machine three adjacent dimensions are stored and acted upon at any given instant, the cutting head following a parabola running through these three points. Overlapping groups of three points are taken in this way right around the periphery of the part required.

To reduce complication the perforated tape is arranged to run at a speed which corresponds to the cutting speed of the machine tool and the store in the computer only retains information referring to the three points in the immediate vicinity of the tool. To reduce to the minimum the number of dimensions to be worked out and subsequently listed in the table, the control unit incorporates an interpolator which permits it to deduce, from a relatively small number of " marker " points in the table, a large number of other points lying on a smooth curve through the markers. By interpolating a number of parabolas, these points are then used to give the profile which the tool is instructed to cut. The control system also works out ancillary information, such as, in this case, the varying speed at which the work table on the machine tool must rotate to ensure that the cutting speed is always at its optimum value regardless of the radius at which it is working.



The main control cubicle showing the tape reader in the top compartment. Below and behind are the information stores, interpolator and servo-amplifiers

The copy-miller to which the E.M.I. control system has been applied in the present instance is already provided with an excellent servo-control scheme. The E.M.I. control unit is therefore used only to drive a small servo operating and copying stylus, the movements of which are faithfully followed by the cutter. It is, however, equally able to control the machine feeds directly and this has already been done successfully with other machine tools.

In order to close the servo loop it is necessary to convey information back to the control unit regarding the exact position of the cutting tool. In the Norwich machine this is done by means of a " position identifier " on the copying stylus. In another machine this need has been satisfied by similar mechanisms on the lead screws controlling the feeds but for other applications these position identifiers can equally well be applied to gauging devices, which are less prone to wear and consequent backlash.

It should be emphasized that although the copy-miller at Norwich is intended for highly specialized work, the system of control which has been described is equally applicable to a wide range of machines used in a variety of jobs. The possibilities which it offers of making a single development prototype immediately the paper work involved in the design has been completed, and at no more cost than a mass production part, or of making changes during production runs without scrapping costly templates or enduring long waits for making and setting up new ones, are of the greatest possible interest to all production engineers.

In case the impression may be given that the control scheme involves the use of large numbers of valves and associated circuitry, it should be pointed out that straightforward electrical engineering principles only are employed in the computer, which is of the analogue type. Altogether, only about 20 valves are used and these are incorporated in normal servo-amplifiers and power supply units.

With the Norwich machine it is now possible, on completing the necessary design drawings, to produce a cam in two hours using only semi-skilled labour. Previously the same job took something of the order of three weeks and required highly skilled labour. The economic advantages of the automatic copy-miller are thus obvious. Because the present machine operates by applying varying pressures on the copying stylus of the copy-miller, cams with a very rapid fall-away can be produced accurately. This is not the case with a straightforward copy-miller since, with a rapid fall-away, side thrust on the copying stylus is introduced and this gives rise to inadmissible errors. In other words, cams which cannot be copied in the normal way can be reproduced over and over again on the Norwich machine.

Cams are not the only items which can be produced using the E.M.I. system; in fact, any complicated machinery process can be tackled. At present the company is investigating the problems involved in the automatic machining of turbine blades. In the aircraft industry it is thought that at some time in the not too distant future aircraft wings will have to be machined from the solid metal for economic reasons. The E.M.I. system readily lends itself to scaling, so that if the machine were used for making the solid wings of a model aircraft for testing in a wind tunnel the same perforated tape could be used for making the wings of the full-size aircraft if the tests were successful.

N.C.B. Specification

THE National Coal Board has issued N.C.B. Specification No. P130/1955 for " Intrinsically Safe Remote Control Circuits, when associated with Restrained Plugs and Sockets " (price 3d, from N.C.B. Production Department, Hobart House, Grosvenor Place, London, S.W.1). This specification has been prepared and approved jointly by the National Coal Board, the Ministry of Fuel and Power and the British Electrical and Allied Manufacturers' Association. The B.E.A.M.A. reference number for the specification is ISC/1955.

The purpose of the specification is to lay down boundary conditions with which the circuits must comply and thus ensure that the remote control unit away from the gate end box can be used with any gate end box that has a circuit complying with the specification. The specification defines the boundary conditions for intrinsically safe remote control circuits when associated with restrained plugs and sockets. The circuit requirements are, of course, detailed in the specification, numbering twelve major ones, some of which have sub-sections.

British Nuclear Energy Conference

PROCEEDINGS AT THE INAUGURAL MEETING

THE inaugural meeting of the British Nuclear Energy Conference, sponsored by the Institutions of Civil, Mechanical and Electrical Engineers, the Institute of Physics and the Institution of Chemical Engineers, was held last week at the Institution of Civil Engineers. About 1,600 people attended.

Sir Christopher Hinton

In his opening address, the chairman, Sir Christopher Hinton, said that the new industry of nuclear engineering had spent the first ten years of its life almost entirely in meeting military demands and during that time it had worked behind a curtain of secrecy. But now nuclear engineering had emerged from that stage and had been established by the recent Government White Paper as an important industry in its own right, an industry on which £300 million would be spent in Great Britain alone between now and 1965, and on which, by 1975, the expenditure in the home markets would be some £200-£300 million a year.

It was, he thought, important that they should get this new business into its correct perspective. They must not regard it as being a completely new technology. It was rather an extension and a development of existing technologies. In the power stations which were at present being built or which were now being designed, one-third of the expenditure was on plant which was strictly conventional in its design and construction and might be found in any other power station. In the remaining two-thirds the materials and many of the techniques of construction were conventional. Indeed, he thought that they ought to attribute this country's present satisfactory position in the field of nuclear energy not to the ability to forge technologies which were completely new and revolutionary, but rather to the ability which had been shown in adapting and developing existing techniques to problems which were completely new.

In the past, when new technologies had been evolved in the world of engineering, there had been a tendency to form new institutions to serve the interests of the engineers engaged in the new field. Such a development had been felt to have many disadvantages in connection with nuclear engineering, and instead five great Institutions had formed collaborative arrangements which they felt would best cover the interests of engineers and applied scientists working in the atomic energy field.

After briefly describing the objects of the Conference, Sir Christopher said that it aimed at achieving its objects without in any way taking from the constituent Institutions any of the responsibilities which they held individually; it aimed at being a collaborating rather than a controlling body.

Atomic Energy Authority

In a paper on "The United Kingdom Atomic Energy Authority and its Functions," Sir John Cockcroft, director of the Harwell Research Station, said that the U.K.A.E.A. had three main groups: Weapons, Industrial, and Research. The Research Group carried out research and development directly relating to the civilian application of atomic energy, and during the last three years it had been possible to turn an increasing effort of the Research and Industrial Groups towards the development of nuclear power. The Industrial Group designed and operated factories for the production of uranium metal and the fissile materials uranium 235 and plutonium. It had also a design office for the design of pioneering types of nuclear power stations. The Industrial Group had also a Research and Development Branch which carried out experimental research into the operational problems of the factories and into specific development problems of new plant and nuclear power stations.

Sir John Cockcroft

Dealing with the choice of reactor, he said that an essential feature of the graphite-moderated reactors, which the White Paper referred to as Stage 1 reactors, was that they would produce plutonium as a by-product that could be stockpiled and used for more highly rated reactors requiring enriched fuel in Stage 2 or Stage 3 of the programme. The White Paper envisaged a change to the more highly rated reactors of Stage 2 towards the end of the ten-year period. Higher ratings of up to 5 MW per ton of uranium could probably be achieved by using water or liquid sodium as the heat transfer medium. Present feeling at the U.K.A.E.A. was that resources could be found by the Authority for only one Stage 2 reactor.

Stage 3 of the programme aimed at breeding, either by homogeneous reactors using the U233-Th fuel cycle, or the fast reactor using the Pu239-U238 fuel cycle. Although work was proceeding vigorously on Stage 3 reactors, it was thought that the development period would be long, and any large-scale contribution to nuclear power from such breeders was likely to be in the 1970s rather than the 1960s.

Dealing with the procedure in the development of new reactors, Sir John said that industry was associated with each stage of reactor studies. At Harwell 42 representatives of industrial organizations were taking part in reactor studies at the research or feasibility stage. Representatives of the C.E.A. and two industrial groups were now helping with the design study of the pressurized-water reactor.

TYPES OF REACTOR

Stage	Type	Output MW	Coolant	Fuel	Country of Construction
1	Graphite moderated	100–200	Gas	Natural uranium	U.K.
	Graphite moderated	100	Water	Enriched uranium 2·5% U235	U.S.S.R.
	Graphite moderated	75	Sodium	Enriched uranium 1·8% U235	U.S.A.
2	Pressurized water	75	Water	Enriched uranium 1·6% U235	U.S.A.
	Boiling H_2O	180	Water	Enriched uranium 1·6% U235	U.S.A.
	Boiling D_2O	10 (experimental)	—	Natural uranium	Canada
3	Aqueous homogeneous	10 (experimental)	—	U233	—
	Liquid metal fuelled homogeneous	—	—	U233	U.S.A.
	Fast breeder	60	—	Pu–U238 / U235–U238	U.K.

The Industrial Group was working closely with four industrial organizations on the design of the C.E.A. Stage 1 graphite moderated power stations. The design proceeded independently in the separate organizations, but regular meetings to co-ordinate the effort were held to discuss common problems and the contribution of the Authority to the development work.

The homogeneous reactor, which was part of the Stage 3 programme, was being studied with the help of the chemical industry, since this reactor would be a highly specialized chemical plant with built-in facilities for continuous chemical processing of fuel.

Industry was also taking a major part in the design and construction of the new research reactors DIDO and PLUTO, and had already obtained an overseas order for one of these. Another industrial organization was prepared to build "swimming-pool" types of reactors. The export of such reactors would be limited by the availability of enriched fuel.

The production of uranium fuel and the processing of spent fuel was likely to continue to be the responsibility of the U.K.A.E.A. Development of fuel elements which would withstand the irradiation damage during the long burn-up period was probably the most difficult task in the whole programme. Water reactors were likely to use uranium-oxide fuel elements as their main charge, since such elements were not attacked by hot water. If an ordinary light-water moderator was used, however, the reactor fuel must be "spiked" by U235 or plutonium. Plutonium would be used to spike the Stage 2 reactors, as soon as the Stage 1 reactors had produced enough. Thus plutonium-based fuel elements would also be required; perhaps plutonium-oxide would prove to have as good properties as uranium-oxide.

Sodium-graphite reactors would be able to use uranium metal since this was compatible with liquid sodium. Whatever fuel elements were required, they needed prolonged testing in large numbers in the development period.

The processing of spent fuel elements was at present undertaken mainly at Windscale by the aqueous-solvent experimental process.

The details of the fuel-element design had a noted effect on the character of the chemical-separation process. Experience had shown that costs of chemical processing fell rapidly with the increase in the scale of operations. It seemed likely that the existing U.K.A.E.A. factory would be adequate to deal with the programme of nuclear power up to 1975. It was also expected that the U.K.A.E.A. would be able to provide natural uranium fuel for the reactors which might be exported in the 1960s and willing to undertake the processing of spent fuel.

The Central Authority's Views

Mr. V. A. Pask, who is this month retiring from the position of chief engineer of the Central Electricity Authority, and Mr. J. C. Duckworth, the Authority's nuclear power engineer, submitted a paper entitled "The Place of Nuclear Energy in United Kingdom Power Development." The authors said that in Britain the Calder Hall station was expected to start production in 1956, and would be the first nuclear station which could be regarded as a commercial prototype. Its main purpose, however, was not the generation of electricity but the production of plutonium, and it was not until about 1961 that Britain's first commercial nuclear plants designed specifically for the generation of electricity were expected to be in operation.

The initial nuclear plants would undoubtedly have a high capital cost, and the many future possibilities, some of them very attractive theoretically, had led some people

Mr. V. A. Pask

Mr. J. C. Duckworth

to question the wisdom of becoming committed to a heavy programme based on the gas-cooled type of reactor. There were, however, excellent reasons for this. If the strain on conventional fuel resources was to be relieved fairly soon, it was essential to go ahead with the gas-cooled reactor; it was the only type which could be regarded as a commercial proposition at the moment.

Even if the United Kingdom had no annual fuel crises, there would still be a strong argument in favour of starting a reactor programme with gas-cooled thermal reactors. All advanced reactors required fuel which was richer in fissile material than natural uranium, but the only naturally occurring fissile material was the uranium 235 present in natural uranium. The gas-cooled reactor would operate on natural uranium and also produce fissile material in the shape of plutonium, which could be separated from the irradiated uranium fuel element by chemical processes. By crediting this plutonium with a value less than the equivalent cost of uranium 235 from a gaseous diffusion plant, it was expected that electricity would be produced at an economic price.

It was confidently thought that the design which would be developed in the coming months for the first Central Electricity Authority stations would enable the construction cost to be greatly reduced, perhaps to £150 or less per kW.

These early reactors would produce plutonium, which would be extracted and processed by the U.K.A.E.A. for future use. Clearly some credit allowance should be made for this fuel.

Apart from its use by the U.K.A.E.A. in prototypes of more advanced reactors, the use to which plutonium was most likely to be put in the early stages of a power programme was the enrichment of the uranium charge in the improved versions of the thermal reactor.

If, as was likely, the figures for costs from the first nuclear stations were as calculated in the examples in the paper, the net costs of generation should be very similar to those of the most up-to-date coal-fired plant.

More advanced types of reactor would eventually supersede the gas-cooled type, but while the prototypes were being proved, improvements would be made to the gas-cooled type, and it might be many years before it was superseded. Improvements in heat-transfer surfaces, metallurgical developments permitting higher temperatures and the use, possibly, of a different coolant gas might together lead to great advances in heat rating and overall efficiency.

Dealing with future reactors, Mr. Pask said that it was interesting to look at some of these future possibilities particularly those with the unique property of producing more fissile material than they consumed. The first competitor of the gas-cooled reactor was likely to be the light-water-cooled and -moderated reactor. This required enriched fuel, since light water absorbed neutrons more readily than graphite and carbon dioxide. The greatly superior qualities of light water as a moderator and heat-

transfer medium would, it was hoped, permit greatly increased reactor heat ratings and consequently reduced capital costs per kW even after allowing for separately fired superheaters to improve the steam cycle. The light-water cooled and moderated reactor, however, presented problems of its own.

The U233-Th fuel cycle had properties which suggested the possibility of achieving a zero or positive gain factor (i.e. of producing as much as or more fissile material than was consumed) in a slow neutron reactor. This development was not possible, however, until the technology of thorium was sufficiently developed and adequate supplies of pure fissile material were available to start the thorium reactors. There would be an incentive here to increase research on the homogeneous type of reactor with its attendant difficulties and advantages.

In the meantime the U.K.A.E.A. were developing a prototype fast reactor which was expected to give a definitely positive gain factor on the Pu239-U238 cycle.

The possibility could be visualized that in the future a power reactor system would be able, by judicious combination of types, to produce all the fissile material it needed; fuel costs would be reduced to the cost of the chemical and metallurgical processes involved in re-cycling the fissile material, together with the cost of a feed of fertile material.

There was confidence that nuclear power could be made to compete with any other form of electric power generation, and indeed might result later in cheaper electricity. It followed that even the most advanced coal-fired plant now under consideration should be designed for flexible operation and two-shift working. The problem was being examined very seriously and extensive tests on existing plant were being carried out in conjunction with boiler and turbo-alternator plant manufacturers to obtain data on temperature differentials and thermal stresses during starting after various periods of shut-down.

The other approach to be actively considered was, of course, improvement in load factor. In this connection, the enhanced case for pumped storage should be mentioned. The case for pumped storage rested mainly on the reduction in hot stand-by which it made possible during the summer months when it would not be operating but would be quickly available if required. If the time came, however, when the base load was met entirely by nuclear plant the alternative to pumped storage would be new two-shift coal-fired plant with corresponding reduction in fuel-cost savings. Moreover, the pumping would be done by nuclear plant with, it was hoped, very low operating costs per unit.

Dealing with the effect on C.E.A. system planning, Mr. Pask said that the prospect of meeting a large part of future electrical energy requirements by nuclear generation radically altered the picture of future economic system development. The tendency would be to site the nuclear plant in areas where insufficient coal was mined to meet local requirements, and as near as possible to the major load centres.

In the discussion that followed, Mr. J. Eccles (Central Electricity Authority) said that he wished to indicate some of the wider problems which required to be understood, if not wholly solved, by those who carried the main responsibility for furnishing an adequate supply of electricity in Great Britain.

The first question was what was likely to be the magnitude of the electrical demand? This would depend upon the aggregate demand for all forms of energy and the proportion of that demand which would be required as electricity. By 1980 (the period covered by Mr. Pask's paper) the total inland coal mined might not exceed 225 million tons per annum, so it was necessary somehow to bridge the gap in total energy requirements in this country between 225 million and something of the order of 400 million equivalent tons. After allowing for possible consumption of oil, it would seem that nuclear energy would have to produce electricity equivalent to 33 million tons of coal. In his opinion, this formed the lower limit to the nuclear power programme over the next 25 years. The upper limit would be set by the technical and manufacturing ability to produce economical nuclear power stations and by the economic attractiveness of this form of fuel as compared with, say, imported oil. It might well be that by 1980 about 50 million tons of coal would be converted into oil, which would leave an upper limit of 83 million tons equivalent to be produced by nuclear power.

Was it physically possible to create nuclear power stations at the rate envisaged in the paper? In effect, the authors said that twenty 200 MW stations were required to be in operation by 1965, a further eleven by

TOTAL POWER AND ENERGY REQUIREMENTS FOR YEARS 1965/6 TO 1980/1
(ESTIMATED SEPTEMBER 1955)

	1965/6	1970/1	1975/6	1980/1
1. Estimated peak demands MW	34,500	43,500	55,500	70,500
2. Total plant requirements MW s.o.	39,000	49,500	63,000	80,000
3. Units s.o. from generating stations 10^6 kWh	136,000	176,000	229,000	295,000
4. Units from hydro stations 10^6 kWh	3,500	4,500	6,000	8,000
5. Units required from thermal stations 10^6 kWh	132,500	171,500	223,000	287,000

POWER AND ENERGY REQUIRED FROM NUCLEAR FISSION FOR YEARS FROM 1965/6 TO 1980/1
(ESTIMATED SEPTEMBER 1955)

	1965/6	1970/1	1975/6	1980/1
1. Units required from thermal stations (10^6 kWh)	132,500	171,500	223,000	287,000
2. Units obtained from home produced coal (10^6 kWh)	107,000	131,000	136,500	140,500
3. Units required from nuclear fission and/or imported fossil fuel (10^6 kWh)	25,500	40,500	86,500	146,500
4. Nuclear capacity required to provide (3) MW s.o.	3,900	6,000	13,000	23,000
5. Assumed annual load factor of nuclear plant per cent	75·0	75·0	75·0	73·0
6. Capacity of coal fired plant required MW s.o.	33,500	42,000	48,000	54,500
7. Average load factor of coal fired plant per cent	36·4	35·6	32·4	29·4

COMPARISON OF COSTS OF NUCLEAR AND COAL FIRED PLANT

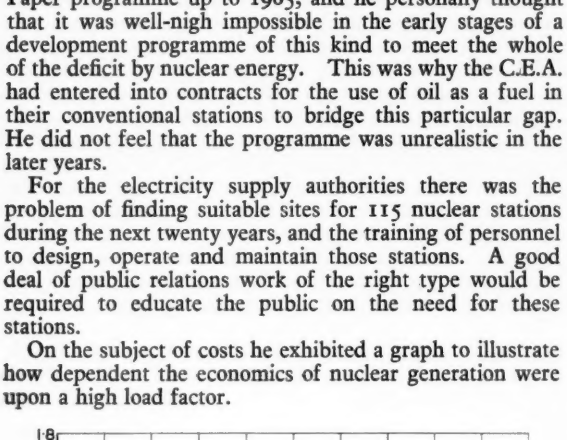
Costs	Nuclear station of 200 MW s.o. 3,000 MW days/tonne	170 MW s.o. 2,000 MW days/tonne	Coal fired base load plant	Coal fired base load plant on coalfields
Load factor per cent	75	75	69 average	75
	£/kW s.o.	£/kW s.o.	£/kW s.o.	£/kW s.o.
Construction cost	125	150	54·3	54·3
Cost of initial charge of fuel	25	30	—	—
Total capital cost	150	180	54·3	54·3
	d/unit s.o.	d/unit s.o.	d/unit s.o.	d/unit s.o.
Annual charges on construction cost	0·336	0·403	0·129	0·119
Annual interest on initial charge of fuel	0·036	0·044	—	—
Other works costs	0·06	0·07	0·052	0·049
Annual fuel costs	0·266	0·4	0·375	0·351
Gross generation cost	0·698	0·917	0·556	0·519
Credit from plutonium at £10,000/kg	0·266	0·266	—	—
Net generation cost	0·432	0·651	0·556	0·519

1970, a further thirty-five by 1975, and a further 49 by 1980, making a grand total of 115 stations. In the five years from 1975 to 1980, nuclear stations would require to be commissioned at the rate of ten a year.

The programme in the Paper was about twice the White Paper programme up to 1965, and he personally thought that it was well-nigh impossible in the early stages of a development programme of this kind to meet the whole of the deficit by nuclear energy. This was why the C.E.A. had entered into contracts for the use of oil as a fuel in their conventional stations to bridge this particular gap. He did not feel that the programme was unrealistic in the later years.

For the electricity supply authorities there was the problem of finding suitable sites for 115 nuclear stations during the next twenty years, and the training of personnel to design, operate and maintain those stations. A good deal of public relations work of the right type would be required to educate the public on the need for these stations.

On the subject of costs he exhibited a graph to illustrate how dependent the economics of nuclear generation were upon a high load factor.



COMPARISON OF GENERATING COSTS OF NUCLEAR & COAL-FIRED STATIONS (200 M.W.S.O.)

The determining criteria in any practical commercial reactor programme must be safety and controllability in operation, cost per megawatt of output, efficiency in the use of fissile and fertile material, ease of maintenance and operational availability.

Mr. G. F. Kennedy (Messrs. Kennedy & Donkin) said that there seemed to him to be three main reasons for the rapid development of nuclear power plant on a large scale in this country. These were (1) the short-term need to bridge the gap between available coal production and the increasing demand for electrical power; (2) the long-term need to generate the whole of the country's requirements of electricity from sources other than fossil fuel, which would allow our remaining reserves of coal to be conserved for use in carbonizing and gasification processes; and (3) the need to develop nuclear power plants suitable for export requirements, so that our manufacturers might capture as large a proportion as possible of the world market for this type of plant.

Mr. A. L. G. Lindley (General Electric Co., Ltd.) said that Sir Christopher Hinton had spoken about spending £300 million on nuclear power plant by 1965. The authors had spoken of doubling that figure. If plant to that extent had got to be manufactured by 1965, it placed an exceedingly heavy burden on industry, not only in regard to manufacturing capacity but also in finding the capital resources with which to manufacture the machinery required. The development of the plans outlined in the paper was not a case of simply deciding the time and extent of entry of nuclear power into the country's generation programme. It was basically a major engineering project which had been taken up by industry.

It was clear that the role which industry must take was that of going forward with reactor development starting from the lead given by the Atomic Energy Authority with the Calder Hall project. That project virtually piloted the form and character of the first stage power stations, although many well-established techniques developed by industry had been used by the Authority in its construction. It was realized by industry and the two Authorities that there could be no short cut in following that lead.

The development of nuclear energy had come about with startling rapidity. The structure of industry was normally very resilient and capable of absorbing the impact of sudden change of effort, but the requirements of this effort were primarily an unusually heavy demand for men with highly specialized experience. It was evident that there were not enough men of that standing in the country to man the effort and at the same time maintain the pace on other work. A second industrial revolution was in progress, and vital new development was going on in many industries. The overall picture was an expanding demand for men and capital. To go forward with nuclear power, sacrifices had had to be made in the electrical industry, and men with specialized knowledge had been transferred to take up that work. Means would have to be provided to expand the numbers of technical men produced by the universities and to attract them to industry. There was a strong case for industry and educationists to meet and agree on some plan to produce the men within the required time.

Consideration should be given to the financial burden which industry had to accept to make possible the rapid development needed. Money was not readily available to industry for that purpose, although the Chancellor had made it clear that it would be made available to the purchasing authority.

Complementary to the nuclear programme was the development of new designs of large steam turbines for shift work conditions in conventional fuel stations. He wondered how far the figures in the paper relating to the cost of power generation had to be taken into account in the development of nuclear power. The stark fact was that there must be electrical power in ever increasing quantity in spite of the decline in availability of conventional fuel if the needs of the expanding economy and rising living standards were to be satisfied.

As far as could be seen, nuclear fuel would largely have to take the place of fossil fuel in the long run whatever the cost of electricity generation. It was as well to recognize that now and also that the present phase was long-term development leading to the time when fossil fuels would only be used sparingly for essential processes.

Sir Claude Gibb (Nuclear Power Plant Company, Ltd.) said he was quite certain that industry could deal with the programme envisaged by the authors, and must do it if the nation was to survive, and pointed out that the technical effort required to produce an equivalent number of megawatts sent out was not very different whether it was done by nuclear or fuel fired stations.

The authors, being subject to a certain amount of Ministerial direction, were understandably a little shy in stating outright that nuclear power would be the salvation of the electricity supply industry and thereby of the country's national standard of living. That the authors envisaged a rate of growth of nuclear plant far greater than proposed in the Government White Paper was a great encouragement to those who had studied the demand and supply position of British coal.

The not very distant future would demonstrate fully the wisdom and farsightedness—one might say the vision—of those who decided to build gas cooled reactors at Calder Hall, to become the prototypes for the true industrial development of nuclear power. They were ideally suited for the immediate needs of Britain, and they would not be outmoded by subsequent developments of reactors requiring enriched fuels. A considerable number of reactors utilizing natural uranium as the primary fuel would always be required. The concentration of effort by the Authority upon gas cooled reactors for the first prototype and commercial nuclear power stations would be proved to have been the correct policy and would give Britain a commanding lead in that new field.

Health and Safety

Dr. A. S. McLean, presenting the first part of the paper on "Health and Safety in the Nuclear Power Industry," said that radiation hazards were beginning to be measured in terms appropriate to the assessment of the risks of accident and injury in other walks of life; and the essentials of radiation protection had turned out to be rather less unusual and rather more conventional than they had at one time appeared to be. It had been shown that, with constant attention to health and safety at each step in the planning, design and operation of atomic energy installations, thoroughly effective protection could be provided for workpeople and neighbours alike.

In recent years experience had shown that the incidence of disease among atomic energy workers showed no abnormality except in terms of sickness absence, by which criterion it was below normal, but that was not surprising in view of the very great care which was taken to ensure the continuing health and well-being of radiation workers. Among the many thousands employed by the Atomic Energy Authority, no case of radiation injury had been observed, nor had any strange new disease made its appearance. Continuous individual measurements of external radiation exposure showed an average in the region of one-thirtieth of the maximum permissible level, and the corresponding figure for internal contamination was even less.

No precise relationship between radiation dose and genetic effect had been established for the human species, and it was unlikely that a real correlation would be forthcoming for many years. The only comparison was with natural radiation to which the human race was constantly subjected. The aggregate gonad dose of natural radiation received by the population of this country was about 5,000,000 man-rads annually. The additional dose from all diagnostic X-ray examinations was about 5 per cent of that figure, and the contribution of the atomic energy industry amounted to about one-twentieth of 1 per cent.

Dr. W. G. Marley, who presented the second half of the paper, said that it was normal in the chemical separation plants of the atomic energy industry for quantities of the order of 10,000 curies to be manipulated routinely in a single batch in industrial processes, often involving inflammable solvents. In many nuclear reactors, moreover, there were several millions of curies of radioactivity locked up in the uranium metal fuel elements. Experience had shown that there was no fundamental difficulty in ensuring thorough shielding protection for the workers. The particular problems were the facility of safe maintenance operations and economic considerations.

Dr. A. S. McLean

Dr. W. G. Marley

If the industry were comparable with agriculture, engineering and chemicals, five deaths might have been expected in cumulative experience of the industry. There had, in fact, been only one death, and that occurred in 1949 as a result of a 50ft fall from a platform, a typical industrial accident quite unrelated to radioactivity. The atomic energy industrial accident rate was remarkably good at 2,000 per 100,000 man-years, and was equivalent to the safest occupations.

There had been no instances in the United Kingdom of any detectable injury arising from external radiation. In the history of the atomic energy industry there had been only two fatal accidents due to radiation, and those occurred in the U.S.A. at the Los Alamos laboratory in New Mexico. In each incident one man was killed and a few were injured by the effects of radiation. As far as could be determined, the injured recovered completely.

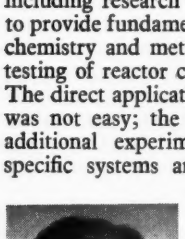
The possible consequences of a large-scale release of radioactivity in the event of accidents to a large nuclear reactor had long been recognized as an important factor in the development of nuclear power. The problem had become more pressing with the rise in total power and with the very high heat ratings in some of the designs now envisaged. Power reactors were now being built within special enclosures designed to guard against possible release of radioactivity and it was considered that an adequate degree of containment could be maintained by sound principles in the design, construction and operation of such reactors. The siting of high-power reactors with suitable engineering safeguards would not present a serious problem in the development of nuclear power.

Among the speakers in the discussion, Mr. H. N. Pemberton (Lloyd's Register of Shipping) said that the authors' statement that the development of reactors for power production would not be handicapped by the potential release of radioactivity was partly a hope and partly a prophecy, but it was only true provided maintenance and inspection problems were solved—and they were not entirely solved yet. Looking to the time when reactors of various types would be used for public and private industrial power houses, research in industrial and university laboratories, hospitals and ship propulsion, he said that sooner or later a responsible body must be formed to assume the role of liaison between industry and the Authority and act as the approving authority on the safety of atomic energy plant during construction, operation and any subsequent modification.

Research Reactors

The last paper presented dealt with the use of research reactors in nuclear power development, and was presented by Mr. H. J. Grout, of the Reactor Engineering Division at Harwell. He pointed out that no background of experience was as yet available to guide engineers in the specifica-

tion and design of nuclear power reactors, and it was therefore of paramount importance to ensure that the industry was backed by adequate research facilities, including research reactors of the various types necessary to provide fundamental information in the fields of physics, chemistry and metallurgy and facilities for the study and testing of reactor components under operating conditions. The direct application of these fundamental data to design was not easy; the problems were often so complex that additional experimental evidence of the behaviour of specific systems and components under operating conditions was necessary. It was in this field that the research reactor would play a most important role, just as the wind tunnel did in the development of new forms of aircraft.



Mr. H. J. Grout

The radiation shield of a reactor must reduce the considerable outward current of fast and thermal neutrons and gamma rays to a biologically-acceptable level at the outside, and attenuation factors of the order of 10^{-9} were involved. In some applications, such as experimental and propulsion reactors, a thin or minimum-weight shield might be of the first importance, and this might be achieved by using high-cost materials such as barytes and steel-shot concrete, lead and polythene. The experimental determination of the effectiveness of such shielding and of streaming and scatter in annuli and ducts was being urgently pursued on existing research reactors and by the construction of a special shielding reactor.

Tests on complete prototype units were necessary to enable a full appreciation to be made of the success of a particular design, but two rather serious technical limitations must be recognized. First, it was impossible to carry out accelerated tests on a full-sized prototype to establish the safe upper limit of burn-up, since this meant operating the element at many times its designed rating, altering radically many of the factors which would contribute towards failure. This could be overcome to some extent by altering the physical dimensions of the test fuel elements so that rapid burn-up tests could be achieved without markedly altering the other important factors. The second difficulty was that fission, as the result of a test thermal neutron flux, took place only in the thin outer layer of the element, and the results could not be used to predict the behaviour of the element under fast-reactor operating conditions.

Although much engineering research could be done in the conventional manner, there was need to test predictions and components under working conditions. A research reactor designed to do this enabled the engineer to build up in a suitable facility a pilot-plant-sized installation complete with fuel elements, coolant circuit and specialized instrumentation. Such "active hot loops" were certain to play a major part in nuclear power development in the next decade.

Comparing the various reactor systems available, he said that graphite natural-uranium systems provided a large volume of experimental space, but the neutron flux per MW was low, and excessively large and powerful systems would be needed for technological work. The D_2O natural-uranium systems, of which NRX in Canada was an example, provided fluxes high enough for technological work and reasonable experimental volume, but the reactor tended to be of high power and thus rather expensive. The enriched-uranium graphite H_2O-cooled system was an example of one of the many variants possible once an adequate supply of enriched uranium was available. There was a reactor of this type in the U.S.S.R. Enriched-uranium D_2O-moderated-and-cooled systems provided intense neutron fluxes for a low power output; the experimental volume was small, but could be increased by the use of a D_2O reflector. DIDO and PLUTO were examples of this type. Enriched-uranium H_2O-moderated-and-cooled systems were similar to the last-mentioned, but the high flux zone was very restricted unless use was made of a thick beryllium reflector. Finally, there was the enriched-uranium homogeneous system, of which only small units had been built.

The Authority had in operation the research reactors GLEEP and BEPO, and under construction a high-flux general-purpose reactor of the D_2O enriched-uranium type, a bulk shielding facility and two material-testing reactors. The need for high flux testing facilities had led the Authority to undertake the construction of three additional research reactors providing a maximum neutron flux of 10^{14}. The first of these, DIDO, should commence operations in the autumn of 1956, and the other two would be completed by the end of 1957. All three would operate at a thermal output of 10,000 kW.

In the immediate future the need was for high-flux material-testing reactors with facilities for loop testing on a pilot-plant scale to support the development of solid-fuelled thermal reactors operating at about 2 MW per kg of fissile material, equivalent to a neutron flux of 5×10^{13}, since this type of reactor was likely to be the main support of the nuclear power programme in the immediate future. The development of the more sophisticated power systems such as the homogeneous fast breeder would pose special problems which might demand the construction of specially designed prototypes.

Mr. D. R. Chick (head of the Nuclear Physics Research Laboratories, Associated Electrical Industries) said that discussion of the part which a research reactor might play in the industrial field had been bedevilled recently by the argument that it was no use unless it was possible to carry out accelerated tests, and that this would involve a very high flux and a very large capital cost. However that might be, industry would certainly need fluxes in excess of 10^{13}n/cm^2/sec. The needs of industry could be classified under two heads. First, there were the requirements for testing suggested fuel elements and assemblies. To meet those, it would be interesting to know to what extent

CHARACTERISTICS OF VARIOUS REACTOR SYSTEMS

Fuel	Moderator	Coolant	Fuel Investment	Maximum neutron flux/MW	Core Volume cu ft	Practical upper limit of flux	Examples built or under construction
Natural uranium	Graphite	Air	40 tonnes	$2{\cdot}0 \times 10^{11}$	6,000	10^{13}	Oakridge, Brookhaven, BRI, Belgium, BEPO, U.K. } U.S.A.
Natural uranium	D_2O	D_2O or H_2O	10 tonnes	$1{\cdot}5 \times 10^{12}$	500	10^{14}	NRX, Canada
Enriched uranium	Graphite	H_2O	10kg U235	$0{\cdot}8 \times 10^{13}$	30	5×10^{14}	RPT, research reactor, U.S.S.R.
Enriched uranium	D_2O	D_2O	2·5kg U235	$1{\cdot}0 \times 10^{13}$	12	5×10^{14}	CPS, U.S.A. DIDO, PLUTO } U.K.
Enriched uranium	H_2O	H_2O	4·5kg U235	$1{\cdot}0 \times 10^{13}$	3	5×10^{14}	LITR, MTR and others proposed in U.S.A.
Enriched uranium	Homogeneous system		1·0kg U235	$4{\cdot}0 \times 10^{13}$	0·5	10^{15}	Only small units built, e.g. U.S.A. SUPO at 45 MW

material-testing reactor facilities would be available for industrial designs in 1956-60. Secondly, there was an urgent need for reactor facilities under the control of industry, to give a general "feel" of the problem and make it possible to do some designing in earnest. Industry was at least ten years behind the A.E.A. in the matter of a "feel" for the subject and on questions of handling facilities, health and safety. If industry was to play more than a minor part in future programmes it might wish occasionally to challenge the conclusions and ideas of the Authority, and it would be desirable to do this by appeal to experiment.

They had been studying a type of "swimming pool" reactor to operate at 1 MW continuously with a fuel investment of 6 kg of enriched fuel, giving a flux of a few times 10^{13}. A problem would arise with regard to siting, because although there was a Reactor Safety and Location Committee at Harwell, whether it had any legal power or could advise industry and local authorities was an open question.

Dr. H. S. Arms (chief engineer, English Electric Co.) said that a matter of interest to every industrial group participating in atomic power development was the accessibility of research reactor facilities. He believed that the right approach was that for the next few years they should be built, owned, operated and fairly closely controlled by the A.E.A., which must have a much more comprehensive view of the whole situation than any or all of the industrial groups. A second step might be for the A.E.A. to build and own the reactors but to make space available in them on a contract basis to various industrial groups. Finally, most of the larger and possibly some of the smaller industrial units participating in the programme would have to provide such facilities for themselves. The capital and running costs were such that this could not be lightly undertaken. He was willing to believe in the necessity to invest a few million pounds in a research reactor, but it could not be done just now.

Professor Jack Diamond (University of Manchester) claimed that it was a notable feature of the British effort in nuclear energy that no reactor so far commissioned in this country had failed in its purpose.

There was likely to be a high and continuing demand for research reactors having a maximum neutron flux of about 10^{14}, but the requirements of fundamental research and possible future developments pointed to the desirability of fluxes of the order of 10^{15}. Here the rate of fuel depletion would be so great that he wondered whether one of the homogeneous systems could be developed to meet the case. With smaller systems, in which it would still be possible to carry out fundamental research, it should be possible, in association with universities and technical colleges, to make a contribution to the considerable training problem in this new industry.

Mr. J. V. Dunworth (A.E.A., Harwell), dealing with costs, said that a reactor with a flux of 10^{13} could be obtained for the modest sum of £250,000 and would enable many academic studies to be made, but for work in connection with advanced power reactors it would be necessary to have a flux of the order of 10^{14}, and this was the basis of their current programme. Capital charges for these high flux reactors might be £2,500,000 and the total operating charges would approach £250,000 per annum. Elaborate laboratory facilities were needed, and with 24-hour operation the staff in the area of the pile building might number 100, while the design of a major experiment to go in such a reactor might easily take a year and cost £50,000. With a flux of 10^{15} the operating cost might well reach £1,000,000 per annum.

A 10^{13} flux reactor might well be built for use by an industrial firm or a university in the near future. It was possible to build a reactor giving a flux of 10^{12} using fissile material in solution for a cost well under £100,000, but the facilities which it would offer would be very limited.

He felt that training should be done on reactors which were in existence for other purposes, and training in power reactor operation would naturally take place in the nuclear power generating stations operated by the electricity authorities.

COAL AND ITS CONSUMERS

THAT the techniques for securing efficiency must vary in the different nationalized undertakings was made clear in a paper read to the Royal Institute of Public Administration by Mr. A. H. A. Wynn, scientific member of the National Coal Board, on 28th November. An old-established industry like coal inherits some difficulties which are absent from newer organizations like the production of electricity or atomic energy.

For over thirty years the coal industry was starved of capital, for its owners were troubled not (as to-day) by unsatisfied demand but by surplus productive capacity. For more than a generation the incentives for capital investment or technological progress were very weak. This depressed management and men alike; recruitment fell; technological advances were held back. Such was the inheritance which faced the National Coal Board in 1947. Even to this day the industry is deficient in labour, capital, and educated manpower.

The four components of a progressive policy, said Mr. Wynn, were these: The survey of natural resources; capital investment; technological improvements; research designed to enhance the quality of the industry's products. The first was peculiar to an extractive industry, but the rest were common to all. Mr. Wynn proceeded to describe the organizations maintained by the Coal Board for these various purposes.

Commenting on the Board's research work, he remarked on the small number of men inherited from private ownership with experience in mining research and the still smaller number with experience in machine development. Because of this lack, the Board's expenditure on research was on a very low level compared with that in other industries—less than one-tenth of one per cent of turnover.

Time was needed to overcome such difficulties: it would take years to build up the necessary administrative organizations within the industry, still longer for capital investments in new mines and large-scale reconstruction to mature, or to develop and manufacture new machinery and educate management and men in new ways. It took time to overcome the momentum of decline.

Difficulties would arise because of the unequal rate of capital expansion in coal-consuming and coal-producing industries. Notable among the former were the Central Electricity Authority, the Gas Council, and the coke oven industry. These in the aggregate had been investing capital in their own development at a higher rate than the coal industry. Some compensation might be found; by research, development and investment the efficiency of coal utilization might be increased, so as to ensure a further expansion of the British economy in spite of stationary coal production. Or imported oil could provide a limited but valuable supplement—for a time which was unpredictable.

Nevertheless, any estimate of the country's future energy requirements based on the assumption of an expanding economy suggested the wisdom of ensuring more resources to coal mining than in the past.

SOLENOIDS

Survey of Design and Application

By C. E. MACKELLAR*

INDUSTRY'S drive for higher efficiency has forced plant manufacturers to turn to improved methods of automatic control. Designers have found that the employment of solenoids simplifies their mechanical design and gives them the means of placing a prime mover at the actual point required instead of through levers and gear trains.

The principle of the solenoid is not new but the advances that have been made in design and manufacture, even over the past ten years, have brought the modern solenoid into a class where it is accepted as a reliable component affording high efforts within a small space.

The dictionary definition of a solenoid is a "helix of wire, usually copper, wound in the form of a cylinder, longitudinally magnetized with varying intensity," but outside the laboratory the term is now used to describe the complete unit consisting of an electro-magnetic coil (the helix) with its magnetically attracted armature or, as is more commonly described, the plunger.

The basic components of a solenoid are shown in Fig. 1 where (a) is the coil, (b) the plunger and (c) is the enclosure forming part of the magnetic circuit. The illustration is of a solenoid designed to operate from a d.c. supply and the coil (a) consists of a non-magnetic (normally brass) bobbin, wound with a number of turns of insulated wire and provided with suitable terminals for external connection. The plunger (b) is frequently of mild steel provided with means of mechanical attachment at one end to the apparatus it controls and is often coned at the other end. The design of this cone is important as it determines the resultant force obtained over given strokes. Provision is always made in the design, even where soft irons are employed for the plunger and magnetic circuit, to avoid residual magnetism becoming effective on the de-energization of the coil windings. This takes the form of a small non-magnetic disc which is securely fixed to the nose of the plunger.

In certain applications it is desirable to have a thrust movement in place of the conventional pull and, to meet this, thrust rods are provided which are attached securely to the nose of the plunger and pass through the outer magnetic frame. The ends of these thrust rods can be arranged for any desired form of attachment. The solenoid therefore provides a convenient means of obtaining a mechanical movement, right at the point required, and with electrical control which may be remotely placed. The electrical control may be hand operated by a simple push-button or actuated by the machine itself over a sequence of operations.

Some typical d.c. solenoids are illustrated in Figs. 2 to 4, Fig. 2 showing a small unit with a maximum plunger movement or stroke of 1in and a pull or effort up to 10 lb. A medium-sized solenoid is illustrated in Fig. 3, which is of a heavy duty design totally enclosed and capable of exerting a pull of 28 lb over a stroke of ½in continuously rated or up to 75 lb over a similar movement on short rating. A still more powerful unit is shown in Fig. 4 which has a pull of 110 lb over a stroke of 1in continuously rated and may be used for efforts up to 600 lb over 1in on short ratings.

Before deciding upon a suitable design a number of factors must be considered. These are:—(*a*) the supply voltage available; (*b*) the direction in which the movement is required, e.g. to pull or thrust upwards, downwards or horizontally; (*c*) the total effort required and whether this is at the beginning of the plunger movement or towards the end; (*d*) the total movement or stroke required; and (*e*) the cycle of operation expressed in time energized and time de-energized.

A study of the graph shown as a typical example in Fig. 5 clearly indicates how the pull obtained varies over the maximum permitted stroke of the plunger. It is possible, however, for designers to produce force/stroke curves to give a wide variety of different forms. Thus, if the load being moved contains a high proportion of spring load due to the type of mechanism, then a curve will be chosen with a sharp upward characteristic to ensure that the spring rate curve at no point crosses the solenoid performance curve. Where the load is all mass, it is often desirable to obtain a steady slow movement to avoid mechanical shock on closing. In this case, the solenoid

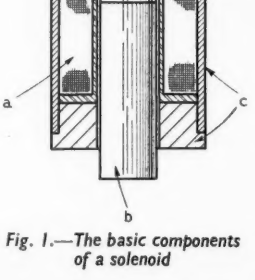


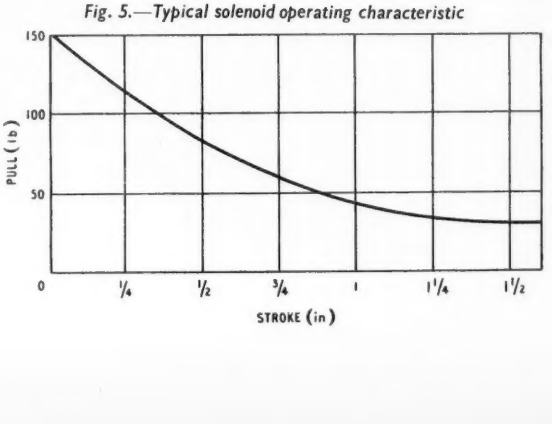
Fig. 1.—*The basic components of a solenoid*

Fig. 2.—*Small solenoid with maximum stroke of 1in and a 10 lb pull*

Fig. 4.—*Heavy-duty solenoid with a 110 lb pull over 1in*

Fig. 3.—*This solenoid can exert a 28 lb pull over ½in*

Fig. 5.—*Typical solenoid operating characteristic*



* Westool, Ltd.

chosen would provide a flat characteristic over the major portion of its movement, rising only to the higher efforts obtained over the final portion of the movement.

It will be appreciated that if a solenoid is required to move in an upward direction, i.e. operating against gravity, then the weight of the plunger itself constitutes part of the load. This should be taken into account in determining the total load required. Conversely, when the solenoid is acting in a downward direction it is assisted by gravity and the plunger weight will assist the total load. This must be allowed for or alternatively its weight should be counterbalanced in some convenient way.

On d.c. supplies above 100 V a solenoid of even medium size contains a coil consisting of a large number of turns of fine gauge copper wire. On interruption of the circuit a relatively high induced voltage is developed across the winding. This can give rise to arcing across the contacts of the operating switch and, in addition, stresses the insulation of the windings to the frame of the solenoid. To reduce this to a safe figure it is customary for the manufacturer to provide a non-linear resistance for connection in parallel with the solenoid winding to act as a surge suppressor. Because of the current requirement that d.c. solenoids shall be controlled by the resistance of the windings and not influenced by any external magnetic variation, it is often preferable to employ these in applications demanding high efforts on a.c. supplies. Metal rectifiers are commonly employed in such cases to provide the d.c. supply.

Solenoids expressly designed for use on a.c. supplies while following the same basic principles, differ considerably in detail. Fig. 6 shows an exploded view of a typical solenoid, designed for use on an a.c. supply. The essential difference in construction when compared with a d.c. solenoid is the use of thin laminations for the plunger and for the yoke or frame. This is necessary to prevent the setting up of eddy currents in the metal, which would result if thick plates were employed. Each of the laminations is coated on one side with a thin insulant which acts as a separator between the adjacent laminations and minimizes the area in which eddy currents can form.

The number of laminations necessary for the plunger and yoke are firmly riveted together, and the mating surfaces carefully ground. Great attention is paid to these details to eliminate noise in operation. Higher efforts are obtained within the same space from an a.c. solenoid as compared with a d.c. solenoid and a typical unit is illustrated in Fig. 7. It is designed for a maximum stroke of 1in and has a range of effort from 1 to 6 lb dependent upon the cycle of operation and the stroke required. A larger model is shown in Fig. 8 which is designed to operate over a maximum stroke of 1¾in and to give efforts varying between 10 to 50 lb according to the conditions of operation.

Mention has been made of the desirability in certain applications of using d.c. solenoids in conjunction with a metal rectifier fed from an a.c. source. A study of a typical volt/ampere curve of an a.c. solenoid will show that with a plunger fully extended the current passed by the windings on switching on is considerably higher than with the plunger closed. It is, therefore, important that the user of an a.c. solenoid shall obtain from the manufacturers details of the volt/ampere operating curve.

In the construction of solenoids of all types, accuracy of mechanical construction is imperative. It is also essential to give attention to the correct treatment of all ferrous parts to render them rustproof. Little has been said so far of the coil construction. Manufacturers pay particular attention to the winding methods and to the impregnation of the final coil and a very high degree of reliability has resulted from the employment of new materials.

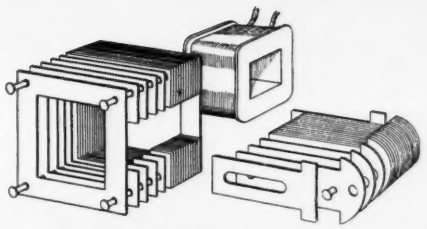


Fig. 6.—Exploded view of the basic components of an a.c. solenoid

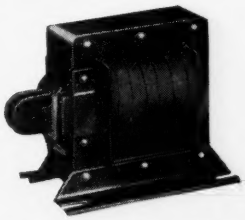


Fig. 7.—This a.c. solenoid has a maximum pull of 6 lb over 1in

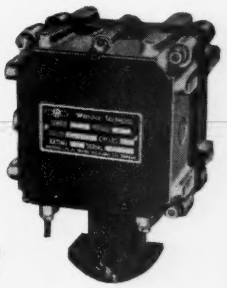


Fig. 8.—Efforts between 10 and 50 lb can be exerted over 1¾in by this solenoid

It may be of interest to outline a few examples of solenoid applications. In aerial survey it is important to take a regular sequence of overlap photographs. Solenoids are used to control the camera shutter and they are fed from an impulse source controlled by the height and speed of the aircraft from which the photographs are taken. Once started, the exposure sequence is completely automatic.

Again, in the case of military aircraft, solenoids are employed as the main control for machine-gun and cannon gear releases, bomb rack release, bomb sight computors, as well as in other equipment where instantaneous operation is required either from manually operated buttons, or from an automatically pulsed supply.

In the domestic field a very well-known washing machine is controlled by solenoids operated through an automatic time switch. Solenoids control the sequence of hot and cold water supply to the machine, empty the water and change speed from the main motor drive. In the industrial field solenoids are commonly applied to the braking mechanism of electric hoists, deflector controls on belt and gravity conveyors, passenger lifts and on numerous types of machine tools.

Acknowledgment is due to Westool, Ltd., for placing photographs, graphs and other data at the disposal of the writer.

Research in Industry

THE third E. F. Armstrong Memorial Lecture was delivered to the Royal Society of Arts on 23rd November by Dr. B. K. Blount (Department of Scientific and Industrial Research), who indicated what he considered would prove to be the right pattern of research in industry. First, the best place for pure research was in the universities, in view of the interaction of ideas found there; industries requiring extra-factory research should not set up research teams in isolation. Applied research was best done directly by industry in its own laboratories, which should preferably be located physically and spiritually within the industry concerned. In the many instances in which research ought to be organized co-operatively, the research associations would be of continuing importance. Government was doing directly much civil research of interest to industry; any subjects that could be properly handled by industry should be transferred to it.

Tri-Dimensional Analogue Computer

AT the Institution of Electrical Engineers the discussion on the paper "Tridac, a Large Analogue Computing Machine," a summary of which appeared in our last issue, was opened by Mr. J. F. Coales (Cambridge University) who referred to the relative merits of analogue and digital computers. With the analogue computer it was easier to see what was going on in the different parts of the system while it was happening. Calculations for Tridac could not be done in real time with a digital computer, chiefly because of axis conversion, which involved complicated simultaneous equations. Large simulators for guided weapons required a flight table on which to test component parts. As no such table had been satisfactorily designed an important reason for using an analogue computer appeared to go by default. A very much simpler direct-coupled amplifier of the drift-compensated type was still a prime requirement. A reliable multiplication system was essential, and the development of simple digital multipliers with a convenient form of analogue—digital conversion would remove the difficulty of analogue multiplication.

Mr. F. Raymond (Société d'Electronique et d'Automatisme, France) said that, to cope with velocity of roll, a combined analogue and digital machine had been adopted. It was not large or costly but could be rapidly operated. The digital section took charge of those parts of the operation which required high accuracy. Its speed of 200 operations per second was satisfactory for changing from one system to another.

Mr. W. R. Thomas (Elliott Brothers) submitted that the need for accuracy lay in the kinematics, which formed only a small part of Tridac. The vast mass was taken up in simulating any possible airframe and this meant that large problems could be put on the machine. The large size of the machine was due to that desire to achieve great flexibility and universality and to cope with all foreseeable problems. If the machine had been built in the light of experience available in 1949 only, it would now be out of date. He disagreed with Mr. Coales about the d.c. amplifier. The limitation was not in the drift of the d.c. amplifier but in components such as resistors and condensers. The multiplier problem was well on the way to solution by means of the step multiplier which was, he granted, a mixture of analogue and digital techniques. These two techniques could be married and the accuracy of Tridac improved by building digital techniques into the kinematics where the programming was reasonably standard. Where frequent change was required and where one wanted to get the feel of what was happening, one had to stick to the analogue technique.

Mr. C. A. A. Wass (R.A.E., Farnborough) said that the advantage of the real time scale might be worth forgoing if this brought compensating benefits, such as decrease in size or complexity but the cost of such benefits in terms of reduction of computing speed was large. Looking to the future the designer would have greater difficulty in deciding between the two kinds of computer in view of the probable large increase in speed of digital machines and the only marginal increase in the accuracy of analogue machines.

Mr. E. G. C. Burt said that the final output of the machine was not a collection of numbers and graphs. It was an appreciation of the various factors influencing behaviour. It would include methods of predicting the general system behaviour from particular cases studied on the simulator. Tridac should therefore not be considered in isolation but as part of a theoretical-cum-simulator attack on a problem in which the smaller machines, analogue and digital, played their part.

Mr. L. E. McAllister said that ability to obtain a physical picture of what was going on was a real advantage of the analogue computer. He was not connected with aircraft design, but he had just completed an analogue device which was a servo simulator and could be operated by engineers to set up any problem they were trying to solve by means of cathode-ray tube displays, pen recorders and so on. This was of great advantage as compared with the digital type of machine.

Transformer Ratings

A DISCUSSION on the thermal rating of transformers by the Supply Section of the Institution of Electrical Engineers was opened by Mr. R. A. Grierson, who pointed out that while their capitalized life was usually taken as 25 years, their actual life was related to operating temperatures due to loads imposed and temperature of the cooling medium. Qualifying factors were the temperature-deterioration relationship for solid insulations and oil, and the determination of two temperatures—one as the basis for normal life expectancy and the other as the upper limit for loads.

Laboratory experiments had led to two theories regarding the assessment of ageing—the first on the tensile strength of paper, the second on the rate of chemical deterioration; appreciable differences were apparent at elevated temperatures. Deterioration in non-inhibited oils started to become serious above 75 deg C. Conditions were improved by employing a nitrogen seal or by reducing the temperature of oil in contact with atmosphere by means of a conservator. For normal life expectancy the permissible sustained temperature was generally accepted as 95 deg C, which was used to define the datum point for ageing assessment, but this was coming to be regarded as unduly conservative, since some life tests had shown that a 20-year life-temperature of 120 deg C could be computed. Advantage could be taken of the time delay of oil temperature changes to use higher winding temperatures under cyclic load conditions, calculations on a time-temperature basis being employed to discover any consequent loss of life expectancy.

In the ensuing general discussion reference was made to the need to measure hot-spot temperature in its bearing on transformer life. The winding-temperature indicator in general use was subject to errors of 3 to 5 deg C, equivalent to 4 to 5 years of transformer life. Its replacement by an ambient-temperature-compensated safe-current limiter, using a current element having the same constant as the transformer protected, was suggested.

WASHING MACHINES

Continuing our series of illustrated surveys of domestic electrical appliances, next week (16th December) we shall be dealing with electric washing machines. Included in the particulars to be given in tabular form will be details of the type, size, tub capacity, loading, method of agitation, finish, price, etc. As the demand for this particular issue of the *Electrical Review* is likely to be heavy, orders for additional copies should be placed without delay. In the following survey (6th January) the subject will be electric wash boilers

Japan's Electrical Industry and Trade

By R. E. KAAN, Dipl.Ing.

Endeavours to Recapture Overseas Markets through Improved Production Assisted by Technical Agreements

THE prostration of industrial production, the direct outcome of coal shortage immediately following upon the end of the last war, and the confusion created in the economic life of the nation by lack of electric power, brought home to Japan the precariousness of energy supply and with it the rehabilitation of her electrical industry.

Japan's main effort at present is concentrated upon ways and means of securing a cheap and abundant electricity supply for home consumption, and simultaneously strengthening the nation's competitiveness in overseas markets. Though in recent years Japan's electrical industry has grown considerably, future development will only be possible with adequate cheap power derived from water, coal, or nuclear power stations.

In order to expedite recovery and save development costs, many of Japan's leading electrical manufacturers have entered into technical co-operation agreements with foreign firms, details of which are listed in Table 1.

Table 1.—Japanese Technical Agreements

Manufacturers	Products	Agreement with	Country
Asahi Glass Co.	Glass for T.V. tubes	Corning Glass Works	U.S.A.
Dengyosha Prime Mover Works	Water turbines	S. Morgan Smith Co.	U.S.A.
Fuji Denko Seizo K.K. (Fuji Electric)	Heavy & light engineering, waterwheels, house service meters, gas turbines	Siemens-Schuckertwerke	Germany
" "		Voith	Germany
" "		Jaipur Metal Ind.	India
" "		Escher Wyss	Switzerland
Furukawa Battery Co.	Cables & wires	Nordiske Kabel	Denmark
Hitachi	Steam turbines, boilers	I.G.E., Babcock	U.S.A.
Ishikawajima Heavy Industry Co.	Steam generating devices	Foster Wheeler Co.	U.S.A.
Kawasaki Co.	Prime movers	Escher Wyss	Switzerland
Meidensha Co.	Power plant	Unknown	Switzerland
Mitsubishi Electric	Power plant	Escher Wyss	Switzerland
" "	Turbines	I.G.E.	U.S.A.
" "	Unknown	Sulzer Frères	Switzerland
" "	Electrical machinery & apparatus	International Westinghouse	U.S.A.
" "	Air brake equipment	Westinghouse Air Brake Co.	U.S.A.
" "	Communication equip.	Western Electric Co.	U.S.A.
" "	T.V. receivers & components	R.C.A.	U.S.A.
Mitsubishi Heavy Industries	Double rotation-type steam turbines	A. B. Ljungstrom	Sweden
Mitsubishi Shipbuilding & Eng. Co.	Water, steam & gas turbines	Escher Wyss	Switzerland
Nippon Electric	Radio valves, T.V. receivers	R.C.A.	U.S.A.
" "	Powder metallurgy	American Electro-Metal Co.	U.S.A.
" "	Tetrodes & T.V. receivers	E.M.I.	U.K.
Osaka Transformer Co.	Submerged arc welder	Union Carbide Carbon Co.	U.S.A.
Shin Daido Seiko Co.	Electric furnaces	Pittsburg Electromelt Furnace, Inc.	U.S.A.
Sumitomo Electric Industries, Ltd.	Cables	I.S.E.	U.S.A.
Tohoku Metal Co.	Magnetic alloys	Western Electric Co.	U.S.A.
Tokyo Shibaura Electric Co.	Petersen coils, steam turbines & generating plant	A.E.G.	Germany
		I.G.E.	U.S.A.

Table 2.—Production of Mitsubishi Electric Co., 1952-53

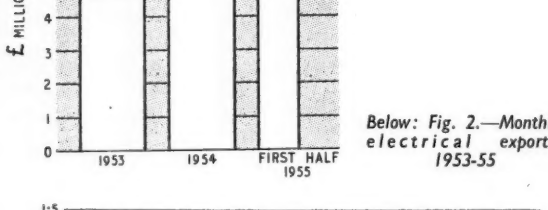
Class	1952 Million Yen	1953 Million Yen
Motors	3,277	3,710
Generators	2,287	2,803
Transformers	2,184	2,316
Switchboards	2,356	3,103
Household meters ..	974	936
Traction equipment ..	641	1,322
Car equipment	789	1,434
Sewing machines	1,000	1,060
Total, incl. items not listed above	18,244	22,407

One of the most formidable competitors to the United Kingdom is the Mitsubishi Electric Mfg. Co., a subsidiary of the great Mitsubishi concern. Founded in 1921 with a capital of 15 million yen, the company took over all the factories and business of the electrical machinery section of the Mitsubishi Heavy Industries, Ltd. During the 1939-45 war the company lost a third of its assets, besides forfeiting its overseas properties. The capital was increased to 550 million yen in 1948, to 1,200 million yen in 1950 and to 2,400 million yen in 1952.

The company owns and operates at present thirteen factories, including a new plant for electronic equipment, employing a total labour force of 17,000, and disposing of their products through their own sales departments and 70 agents in the home market. The output of this company representing more than 15 per cent of Japan's total electrical production is very wide, as is shown in Table 2.

This company manufactured during last year 60 per cent of Japan's prime movers, 36 per cent of her mercury-arc rectifiers, 32 per cent of her circuit-breakers, 27 per cent of her fans, 16 per cent of her motors

Left: Fig. 1.—Japanese electrical exports, 1953-55



Below: Fig. 2.—Monthly electrical exports, 1953-55

and 15 per cent of her transformers. While most of the products were manufactured for the home market about 8 per cent of the total sales went overseas, including the traditional United Kingdom markets of India and Pakistan.

Though Japan's export outlook is at present somewhat clouded by high production costs caused by the operation of obsolete machinery and out-of-date manufacturing methods, she managed to raise her electrical exports by 72 per cent during the first half of 1955 against last year's corresponding figure (see Figs. 1 and 2). At present, every effort is being made to modernize production facilities in order to make the products, ranging from heavy plant to domestic appliances, more competitive in overseas markets (Table 3).

After a temporary setback during 1953 (see Fig. 3), Japanese electrical exports recovered again last year. Though her competition, unlike that of Western Germany, is not felt in most territories, there can be no doubt that the most strenuous efforts will be made by her industry to compete more effectively in the future, particularly in transformers, motors, fans, porcelain insulators and electricity meters.

Table 3.—Japanese exports and main markets in 1954

Class	Values (£000)	Countries (values £000)
Generators, over 5,000 kg. ..	88	Korea (31)
Generators with motive machinery	204	Korea (68), Brazil (60)
Motors between 25 and 100 kg. ..	515	Pakistan (299), Formosa (121)
Transformers and convertors, above 1,000 kg.	172	Formosa (75), Korea (37)
Circuit-breakers ..	67	Indonesia (61)
Telephone apparatus	184	Formosa (63)
Radio receivers ..	357	Indochina (167)
Watthour meters ..	230	Formosa (142), Turkey (44)
Fans	539	Iraq (120), Thailand (108), India (31).
Porcelain insulators	644	India (316), U.S.A. (69), Australia (64)

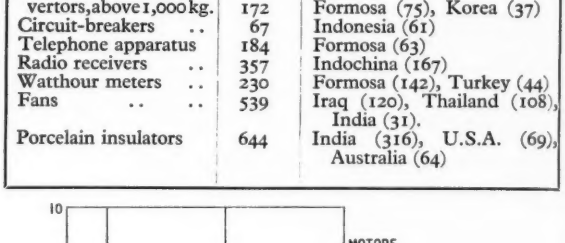


Fig. 3.—Broad analysis of 1952-54 exports

Polarographic Research Laboratory

IN the highly specialized field of polarography the present shortage of semi-skilled and skilled technologists is preventing the benefits of this technique from being freely available to science and industry. In some countries this shortage of polarographers has been met by the formation of groups of experts whose services to science and industry are available to ensure that the benefits arising from the use of this technique are available to all.

The earliest example of this type of specialist organization was the Central Polarographic Institute of Czechoslovakia established in Prague by Professor J. Heyrovsky, who invented the polarograph in 1925. This Institute is noted for its pioneering work in developing the theory of polarography and applying this knowledge generally to the problems of medicine and science.

In Great Britain no exclusive outstanding experimental and development organization has been created, although many small units have been doing valuable work in this field. The Cambridge Instrument Co., Ltd., was probably the first maker of polarographs in this country, the earliest instruments being sent out just before the last war. Dr. G. Jessop of the Research Department of the company has done a large amount of work on the development of polarographic instruments and techniques. Further, the Research Department has always endeavoured to help users of polarographs in the solution of their own particular problems. The volume of such work has so increased that it has not been possible, without delaying more fundamental research, to give the immediate service which is very desirable with such problems.

To remove this difficulty and to enable the company to develop its polarographic equipment more rapidly, a special Polarographic Research Laboratory was recently opened by Professor J. Heyrovsky and it will be in the charge of Mr. W. J. Parker, B.Sc., A.R.I.C., A.M.Inst.F., A.M.Inst.Gas E. The opening ceremony under the chairmanship of Sir J. A. N. Barlow, Bt., G.C.B., K.B.E., was attended by a representative gathering from the academic, research and industrial fields. This laboratory, which will be employed exclusively on polarographic problems and development, is adjacent to the company's Cambridge works and the work carried on there will be carefully co-ordinated with the programme of work which will continue in the main Research Department. The specialized services of the laboratory will be available for advice and help to firms and to research workers interested in this subject, and it will be fully equipped for the demonstration of polarographic instruments and techniques.

INDUSTRIAL NEWS

English Electric Dollar Orders

The United States Army Corps of Engineers has awarded a contract for the manufacture and delivery of a 90,750/121,000 kVA 13·2/161 kV three-phase, 60 c/s power transformer, with accessories and spare parts, to the English Electric Export & Trading Co., Ltd. It will be recalled that earlier this year the company was the lowest bidder in the first invitation for this contract, but all bids were cancelled and the invitation was reissued.

The transformer will be installed in the switchyard at Table Rock Dam, located on the White River in Taney County, South West Missouri, and will serve two 52,632 kVA generators. It will be of the two-winding, oil-immersed, self-cooled, forced-air cooled, Class OA/FA, dual-rated, inert gas-filled, three-phase type, suitable for outdoor operation. In November of last year English Electric were awarded the contract for the two 68,000 h.p. vertical Francis water turbines for this project.

The Tennessee Valley Authority, Chattanooga, has placed a contract for the manufacture and delivery of four transformers with the English Electric Export & Trading Co., Ltd. This is the first occasion on which the Authority has accepted an English Electric tender. The transformers are single-phase with three windings for 154/69/13·8 kV. They are of the outdoor, self-cooled type and are rated at 40,000 kVA, 60 c/s. The value of the order is $450,000, and it is reported that this is considerably lower than the lowest American bid and also less than two tenders by other non-American companies.

The Nova Scotia Light & Power Co. has placed a second order with the English Electric Co., Ltd., for a 45,000 kW, 3,600 r.p.m. steam turbo-alternator set, complete with feed heating and condensing plant, for installation at its Water Street power station, Halifax, Nova Scotia. The value of the order is approximately £450,000. The set will be built at the company's Rugby works. The turbine is designed to operate with steam at 900 lb/sq in, 900 deg F at the turbine stop valve and five stage feed heating with a vacuum of 28½in at m.c.r. The alternator is of the hydrogen-cooled type for generation at 13,200 V, 3-phase, 60 c/s.

Damages Award

Damages totalling £5,788 15s 1d, comprising £5,500 general damages and £288 15s 1d special damages, were awarded at the Staffordshire Assizes on 1st December to Stanley Cooke, of Frobisher Hall, near Stone, against the English Electric Co., Ltd., Stafford, for personal injuries arising from breach of statutory duty and negligence. Mr. Paul Layton, for Cooke, said he was an assistant tester at the works. He had to have part of a leg amputated and received injuries to his brain and skull after being seared by a bar in a transformer cubicle carrying 1,300 V.

It was his case that, normally, the door of the cubicle was kept shut and sealed, with a large notice on the door, when the equipment inside was "live." On the day of the accident, he alleged, the door was wide open and the sign removed.

For the company, Mr. John Garrard submitted that perfectly adequate precautions were taken. They secured safety except when someone disobeyed the instructions of his superiors, as Cooke had done. The plaintiff had no business to go into that cubicle and had been told so on more than one occasion. Mr. Justice Stable said the safety precautions at that time were inadequate.

Electrical Exports to Canada

Virtually all the £9 million worth of British electrical equipment sold to Canada each year (with the exception of some heavy plant for power stations) is now approved by the British Standards Institution, acting as agent for the Canadian Standards Association. By this means the equipment goes straight into service without the risk of being returned to Great Britain for costly alterations. This approval-in-advance system is now successfully used by some 400 British firms making products of all kinds.

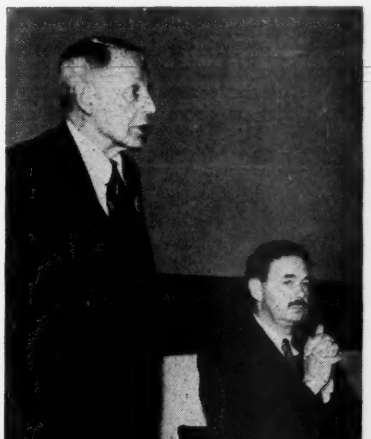
The B.S.I. has now published a new and enlarged edition of its booklet, "The Canadian Standards Association—Information for U.K. Manufacturers Exporting Electrically-Operated Equipment to Canada," which first appeared in 1952. In the new edition a paragraph has been included concerning the approval of equipment incorporating pressure vessels, e.g., motor-operated garage compressors. It points out that there are special Canadian requirements for the certification of pressure vessels having capacities in excess of certain minimum sizes and worked at certain defined pressures. (A B.S.I. leaflet on exports of boilers and pressure vessels is now being prepared.) Another new section describes the availability of a consultative service in Canada concerned with exports of special kinds of wire and cable not subject to approval in the usual way.

The appendices listing the Canadian approval specifications and the appendix giving the names and addresses of the Provincial chief electrical inspectors in Canada have been brought up-to-date. Details of related B.S.I. publications are included for the first time. More detailed information is given on approval of flameproof equipment and on the approval and acceptance of high rupturing fuses. Material is included regarding the approval of stator-rotor units; and the information on the type of service applicable to wires and cables has been amplified and brought up-to-date.

Copies of the booklet are available from the Sales Branch, British Standards Institution, 2, Park Street, W.1, price 5s.

Public Schools and Science Teaching

Only by technical superiority based on science could Britain hope to keep alive, let alone prosper, said Sir George Thomson, F.R.S. (Master of Corpus Christi College, Cambridge), when he addressed headmasters and careers masters of public schools at a three-day convention in Liverpool this week. This convention was organized jointly by British Insulated Callender's Cables, Ltd., the Automatic Telephone & Electric Co., Ltd., and British Telecommunications Research, Ltd., primarily with the object of strengthening the contacts between the science sections of universities, public schools and the respective companies. The programme included visits to the B.I.C.C. works at Prescot, Leigh, Lancs, and Helsby, Cheshire; and to the B.I.C.C. corrosion research and telecommunications laboratories at Kirkby, Lancs, where there was also on view a comprehensive display of railway electrification, overhead lines and other engineering work of the



Sir George Thomson speaking at the Public Schools Convention of Science Teaching. Seated on his left is Dr. L. G. Brazier

B.I.C. Construction Co., Ltd. During the tour of A.T.E.'s main Liverpool factory, delegates visited the company's new school of electronics established recently to train post-graduates, and others with the necessary qualifications, in the latest electronic techniques.

One afternoon was devoted to a conference on science teaching in schools under the chairmanship of Dr. L. G. Brazier, director of research and education, B.I.C.C. The chief feature of the conference was an address by Sir George Thomson on "The Shortage of Scientists"; other speakers included Mr. H. M. Steward, M.P., Mr. N. C. Stamford, M.Sc., M.I.E.E., education officer, I.E.E., and Mr. W. F. Harling, O.B.E., careers master, Marlborough College, and many of the other members present contributed to the discussion. The conference concluded with the showing of the I.E.E. film "The Inquiring Mind."

At a dinner held at the Adelphi Hotel, Liverpool, when the chairman was Sir Rex Hodges, director of B.I.C.C., further reference was made to the success of the conference by Mr. B. L. Deed, O.B.E., headmaster, Stamford School, Lincs.

New "Atlas" Manchester Showroom

A new showroom for the "Atlas" lighting division of Thorn Electrical Industries, Ltd., was opened last week at 9, Stevenson Square, Manchester. One of the principal features is a fluorescent colour comparison section. The comparison spaces may be illuminated with any or all of the different "Atlas" fluorescent tubes and are large enough to accommodate complete settings, even of furniture. It is therefore possible to select accurately the correct tube colours required for any purpose by simulating the conditions in which the tubes will be used. "Colorblend," the company's latest development in fluorescent dimming, is also installed in one of the comparator spaces. A single dial on the small control unit may be operated to mix the light from a triple tube fitting, to show the possibilities for display lighting of this unit. The colour appearances of the range of fluorescent tubes can also be compared on a separate wall unit. Electronically-controlled fluorescent lighting silhouettes a floating ceiling within a recessed area flooded with constantly changing colour. Other special displays demonstrate tungsten filament lamps and fluorescent control gear. A section has also been devoted to the "Tricity Coronet" cooker, together with its ovenware.

Damodar Valley Switchgear

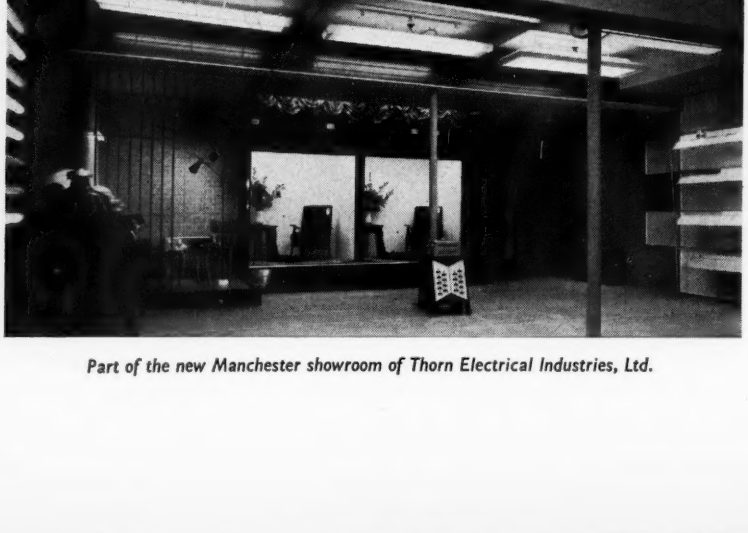
Referring to the article on the Damodar Valley hydro-electric scheme in our issue of 28th October, Mr. F. N. Prangnell, representative for India of A. Reyrolle & Co., Ltd., asks us to mention that his company has supplied between forty and fifty 33 kV circuit-breakers for the scheme.

Indian Railway Order

A *Reuter* message from Delhi states that Associated Electrical Industries, Ltd., has received an order worth Rs.4,500,000 (about £337,500) from the Indian railways for electrical equipment. Altogether India has ordered Rs.22,600,000 worth of equipment for the electrification of the Calcutta suburban line.

Brook Motors Development

In his statement to shareholders, recently issued with the report and accounts for 1954-55, Mr. F. V. Brook, chairman of Brook Motors, Ltd., refers to negotiations for the acquisition of a site for new factory development. The company states that this site, formerly an amusement park, at Hope Bank, Honley, has now been purchased. It is about four miles from the Huddersfield works. The company has been trying for a considerable time to obtain a suitable building area in Huddersfield but has been finally compelled by lack of sites to go further afield. This particular position was chosen because it is between the Huddersfield and Barnsley factories and will involve the minimum extra transport. Hope Bank is a pleasantly wooded area in a country district and every effort will be made to preserve the amenities. Labour will be obtained from further afield and the company's own coaches will be used if necessary as it is desired to cause as little difficulty as possible to other industry in the neighbourhood. About 500 people will eventually be employed, many of whom will come from the Huddersfield works. The factory buildings, expected to occupy initially about four acres, will be devoted to the manufacture of fractional h.p. motors. A new motor design is being developed, intended for the domestic equipment field, for use on washing machines, refrigerators, ironers, drying machines and similar appliances for home and overseas. Output of the new factory will be about half a million motors per annum. In design, construction and size the new building will be similar to the Barnsley factory opened in May, 1954.



Part of the new Manchester showroom of Thorn Electrical Industries, Ltd.

Electrical Engineers Exhibition

Owing to the growth of the Electrical Engineers Exhibition, it has been necessary to obtain larger premises to house the exhibition company (Electrical Engineers (A.S.E.E.) Exhibition, Ltd.). The registered address will remain at 23, Bloomsbury Square, W.C.1, but all correspondence and interviews will be carried out at 6, Museum House, 25, Museum Street, London, W.C.1. The telephone number, Museum 3450, remains unchanged.

Increased Lamp Efficiencies

Considerable increases in the initial lumens and average lumen output through life for all sizes of the "Atlas" "warm white" fluorescent tube are announced by Thorn Electrical Industries, Ltd. The new figures show performance improvements of up to 18 per cent on previous figures. It is emphasized that these new efficiency figures are taken from tests on production tubes; current "warm white" tubes are said to be achieving or even surpassing these values.

Trawlers for Russia

Twenty trawlers are being built for Russia by Brooke Marine, Ltd., and Laurence, Scott & Electromotors, Ltd., are supplying the electrical equipment for the trawl winches, the mechanical part being in the hands of James Robertson & Son, Ltd.

The trawl winch has the normal Ward-Leonard system of control. The drip-proof winch motor is for installation in a deck-house; it develops 175 b.h.p. at 600 r.p.m. It is fitted with the usual magnetic brake with hand release. The drip-proof Ward-Leonard generator has a single end-shield bearing; coupled direct to the engine it develops 146 kW at 750 r.p.m.

The commutator end shaft is extended and flexibly coupled to a 55 kW 220 V level compound wound generator, used for supplying excitation and also the ship's mains while trawling. The controller provides seven steps in the "heave" direction and four in "veer." There is also the usual torque overload panel and emergency stop button.

The characteristics of the equipment follow the company's standard practice for trawl winches. They provide for automatic protection of the engine from overload (as, for example, in the event of the net fouling an underwater obstruction). Under such conditions the winch continues to exert a live pull and resumes the haul automatically when the net is freed. The control gear is simple and reliable and suitable for prolonged service without skilled attention.

Laurence, Scott have also supplied much electrical equipment for the Cunard liner *Carinthia*, to be launched shortly. About 125 electric motors have been supplied, of a total horsepower exceeding 4,000, for the engine room and many other auxiliaries. The largest, for the main boiler feed pump, is 450 h.p. "Scott" winches have also been supplied for cargo handling and for manipulating the gangways. There are twelve 3-ton and two 5-ton cargo winches, of the Scott "Selector" type, and two 2-ton gangway winches.

Awards in Technology

The Minister of Education (Sir David Eccles) has announced the names of five members of the new National Council for Awards in Technology under the chairmanship of Lord Hives (Rolls-Royce, Ltd.). The Council will hold its first meeting on 19th December. The five members are Sir Harold Roxbee Cox, director, Brush Group, etc., and formerly chief scientist, Ministry of Fuel and Power; Sir Arnold Hall, technical director, Hawker Siddeley Group and formerly director, Royal Aircraft Establishment, Farnborough; Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd.; Dr. Idris Jones, director-general, Scientific Department, National Coal Board; and Mr. E. L. Russell, chief education officer, Birmingham.

The Council will create and administer awards in technology which will have a national currency and will be available to students in technical colleges who successfully complete higher technological courses approved by the Council. These awards will be designed to provide at the first level an educational qualification comparable in standard to a university first degree. Appropriate post-graduate awards may be established later.

The Council will be an independent self-governing body operating under a deed of trust and will consist of the five members mentioned and three appointed by each of two Boards of Studies. These Boards will be responsible to the Council for all matters concerned with the approval of courses, including the curricula and syllabuses of courses proposed for the awards, and in particular the standard of the college work in pure science and in technologies related to the courses for which approval is sought; the standard of admission to the courses and of the final examinations; the qualifications of the teachers; the accommodation and equipment; and the conduct of the examinations.

The members of the Board of Studies in Engineering include the principals of a number of technical institutions; Messrs. S. E. Goodall and G. S. C. Lucas (representing the I.E.E.); Sir Walter Puckey (representing the Institution of Production Engineers); and Mr. T. E. Goldup, Mr. J. J. Gracie and Dr. T. E. Allibone (among the representatives of the Minister of Education). There is also a Board of Studies in technologies other than engineering.

The training wing at the sales headquarters, Wednesbury, for the "Servis" washing machines of Wilkins & Mitchell, Ltd., showing (reading chronologically, from left to right) the advance in design from 1930 to the present day

British Plastics Exhibition

The fourth British Plastics Exhibition and Convention—occupying more than double its previous amount of floor space—will be held in the Grand Hall, Olympia, London, from 10th to 20th July, 1957. Parallel with it there will be an international convention.

This exhibition which, until now, has been confined to materials, plant and products of the United Kingdom and the British Commonwealth, is being enlarged and extended and will include exhibits from other countries.

The event, held every other year, with the co-operation of the British Plastics Federation, is organized by *British Plastics*, Dorset House, Stamford Street, London, S.E.1.

Industrial Truck Safety Code

Earlier in the year the Industrial Truck Manufacturers' Association produced an informative booklet which dealt with basic design codes and other factors inherent in the production of safe industrial transportation equipment. The success of this publication has led the Association to produce an excerpt from it, which has been specially designed to appeal to the driver of the equipment. This "Operator's Safety Code," as it is called, illustrates over thirty do's and don'ts, and lists the hazards common to truck operators which the operatives have to overcome. The booklet can easily be slipped into the operative's pocket. Copies may be obtained from the secretaries of the Association, 94-98, Petty France, London, S.W.1 (price 1s each post free, or 10d each for quantities of twelve and over).

Stella Lamps and Fluorescent Lighting

The Stella Lamp Co., Ltd., has announced its entry into the fluorescent lighting fittings market in a four-page, two-colour leaflet describing the first of the "Blue Label" range. This range includes ceiling batten, ceiling vee, industrial trough, slotted light trough and angle reflector fittings. Copies of the leaflet, which gives technical data and prices of the new range, are obtainable from the company at 37-39, Oxford Street, W.1.

Strength of Welded Joints

The amazing strength of weld metal has been demonstrated in a test which was recently made on a prototype 4in mild steel elbow. The elbow was fabricated in mild steel tube and tested under water pressure in accordance with B.S. 1640. The calculated bursting pressure was 12,500 lb/sq in, and the specimen withstood a pressure of 15,000 lb/sq in before failure occurred in the straight length of the tube. The welding was carried out by Messrs. Simmons & Hawker, Ltd., using Quasi-Arc Radian electrodes, and the welds were ground flush both inside and outside before testing.

Aluminium in Building

Because of the interest being shown in the "Aluminium in Building" Exhibition at the Building Centre, 26, Store Street, London, W.C.1, the Building Centre has requested that it

be allowed to remain on view until 31st December and the Aluminium Development Association and the exhibitors have agreed to this.

Tanganyika Radio Exhibition

In order to stimulate the sales of radio sets now that the new Tanganyika 20 kW transmitter gives territory-wide coverage it is proposed to hold an Exhibition of Radio and Electrical Appliances in Dar-es-Salaam during the Easter holidays in 1956. The exhibition is being organized by the Social Development Department and a committee of representatives of commercial firms. A section of the exhibition is to be reserved for electrical contractors.

Plans are being discussed for the formation of a Tanganyika Radio and Electrical Dealers' Association.

David Brown South African Agreement

An agreement, covering the manufacture in South Africa of certain types of heavy gearing, has been completed by the Vanderbijl Engineering Corporation, Ltd. (VECOR), of Vanderbijl Park, and David Brown Precision Equipment (Pty.), Ltd., of Benoni, Transvaal.

Vitreous Enamelling Exhibition

An exhibition of vitreous enamelling opened on Monday last in the Midland Electricity Board's industrial showroom, 247, Chester Street, Aston, Birmingham. The exhibition, which has been arranged in conjunction with Metalectric Furnaces, Ltd., Metal Porcelains, Ltd., and other concerns, shows a number of furnace types including a continuous unit in operation, and there are displays of a representative range of materials and equipment together with samples of finished products in cast and sheet metal. The exhibition remains open until 16th December.

Building Trades Directory

The 1956 edition of Sell's Building Trades List is now available from the publishers, Business Dictionaries, Ltd., 133-137, Fetter Lane, London, E.C.4, price 25s. The present issue is the 27th in the series and its 500 pages contain much that will be of interest to architects, builders, engineers and contractors. Revision has been thorough and where necessary new headings have been introduced, including a plastics section. Altogether there are over 33,000 names, addresses and telephone numbers classified under some 2,700 trade heading.

Hoover Basic Research Department

A new research department has been set up by Hoover, Ltd., at Perivale, Middlesex, having as its function the harnessing of electronic and other modern scientific discoveries and techniques for use in new Hoover products to be developed on a long-term basis. The work of the department will not replace that of the present development team but it will keep abreast of every possible discovery in its field which can be applied to practical ends in the industry.

Dr. D. M. Tombs, recently senior lecturer in telecommunications at the Imperial College of Science and Technology, London, has been appointed as head of the department.

Dominican Trade Fair

On 20th December the Government of the Dominican Republic will inaugurate an International Trade Fair at Ciudad Trujillo, the first of its kind in the Caribbean, to commemorate the achievements of the Republic since the election of President Rafael L. Trujillo twenty-five years ago. The Fair will close on 27th February. It will cover an area of 250 acres and forty-one countries will be participating.

Educational

A course of six lectures on "Transmission System Protection" will be held at South East London Technical College, Lewisham Way, S.E.4, on Tuesday evenings, commencing on 10th January, and a further course of six lectures on "Calculation of Symmetrical and Unsymmetrical Short Circuits" will be held on Tuesday evenings, commencing on 21st February. The fee for each course will be 10s and applications should be made to the head of the Electrical Engineering Department.

Instrument Company's Extended Activities

B. & K. Laboratories, Ltd., are extending their business by including a selected range of British instruments, so that in future stocks of the products of the following firms will be included: Advance Components, Ltd.; Automatic Coil Winder & Electrical Equipment Co., Ltd.; Cossor Instruments, Ltd.; Furzehill Laboratories, Ltd.; and Microwave Associates, Ltd.

So as to cope with increased demands for specialized instruments Rocke International, Ltd., announces that the services of B. & K. Laboratories, Ltd., are now available to their clients, thus relieving pressure on the existing Instrument Division. This service covers the products of a number of overseas factories. All matters relating to import and Treasury licences, pricing, shipping, guarantees and technical specifications are fully covered.

Mr. C. J. Mitchell, A.M.I.E.E., formerly of Messrs. Racal, Ltd., has been appointed chief engineer, whilst Mr. V. R. Moore, who has spent many years, latterly as sales manager, with Advance Components, Ltd., has also joined the staff. Mr. G. W. Bowyer is now head of the traffic department.

Diaries

We have received a neat pocket diary in navy-blue binding from Tube Investments, Ltd.

The 1956 pocket diary received from A. Reyrolle & Co., Ltd., is nicely bound in navy-blue leather.

Change of Name

The Sparshotts Electrical Engineering Co., Ltd., has changed its name to Keeping's Electrical, Ltd.

Trade Announcements

Permanoid, Ltd., has opened a new branch in Scotland at 14, Gibson Street, Glasgow, W.2 (telephone: Weston 2102). The branch will carry a comprehensive range of plastic cables, together with television aerials manufactured by the subsidiary company, Arrell Electrical Accessories, Ltd. It will be under the control of Mr. J. M. L. Morton.

The office of the **London Fan & Motor Co., Ltd.,** is now at 27, Brecknock Road, London, N.7 (telephone: Gulliver 3650 and 2011).

The **Belark Tool & Stamping Co., Ltd.,** has moved to 9, Carnaby Street, London, W.1.

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 16th December:—

PRESTO (design). No. B738,844, Class 9. Electric kitchen utensils.—National Presto Industries, Inc., Eau Claire, Wisconsin, U.S.A. Address for service, c/o Pollak, Mercer & Tench, 134, Cheapside, London, E.C.2.

PROJECTOMATIC. No. 741,743, Class 9. Scientific, cinematographic and sound reproduction apparatus; and electrical apparatus.—Essoldo Circuit (Control), Ltd., Norwich Union Chambers, 42, Westgate Road, Newcastle-on-Tyne.

ETHOX. No. 743,215, Class 9. Electric switchboards, and ETHOX. No. 744,391, Class 11. Electrical heating and lighting installations.—J. R. Ferguson, Tameside Works, Park Road, Dukinfield, Ches.

CELTIAN. No. 744,062, Class 9. Electrodes for electric arc welding.—Quasi-Arc Co., Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1.

HMV. No. 744,861, Class 9. Electric dry batteries.—Gramophone Co., Ltd., Blyth Road, Hayes, Middx.

PORTAMATIC. No. 744,960, Class 9. Radio, telephonic, television and telegraphic instruments, sound recording and sound reproducing instruments and parts.—Dynaport Radio & Television, Ltd., Portadyne Works, 30-34, Gorst Road, North Acton, London, N.W.10.

ORYX. No. 745,223, Class 9. Electrically heated soldering irons.—Electrical Laboratories, Ltd., North West House, 45, West Street, Brighton, 1.

SONIZON. No. 745,261, Class 9. Electronic testing and measuring apparatus and instruments and parts.—Magnaflux Corporation, Chicago, U.S.A. Address for service, c/o Gill, Jennings & Every, 51-52, Chancery Lane, London, W.C.2.

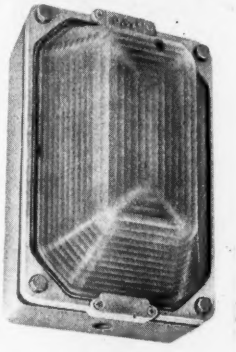
SIESTART. No. 745,352, Class 11. Electric light fittings and parts.—Siemens Electric Lamps & Supplies, Ltd., Caxton House, Tothill Street, Westminster, London, S.W.1.

NEW ELECTRICAL EQUIPMENT

Bulkhead Fitting

A new rectangular bulkhead fitting has been developed by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, to house a 200 W "Osram" lamp. The new unit weighs 18½ lb. It is constructed of cast iron and has a prismatic glass cemented into the front glass-frame. The frame is sealed to the body of the unit by a gasket. A polished aluminium internal reflector with a porcelain e.s. lampholder is provided. There are three tapped ¾in e.t. entries for through or back entry to the unit, and plugs are supplied for two of the entries when they are not in use.

The unit (F.64032) measures 11¼in by 7½in and is finished in light grey stoved enamel. The price complete is £5 10s, a spare glass costs £1 and spare gaskets are 5s each.



G.E.C. F.64032 200 W bulkhead fitting

A.M./F.M. Signal Generator

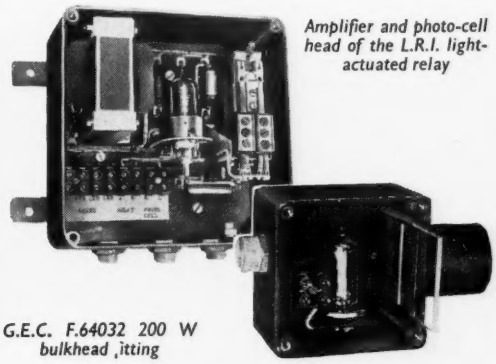
PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2, have introduced the GM. 2889/01, an a.m./f.m. generator with an unusually wide frequency range making it suitable for aligning i.f. amplifiers, discriminators and filters in either the development laboratory or service department. Frequencies from 5 to 225 Mc/s can be covered without switching, thus enabling work to be carried out on Bands I, II or III.

An extremely stable marker oscillator with a range of 15-30 Mc/s and an accuracy of ±50 kc/s is incorporated. There is also a built-in crystal oscillator to provide reference points against which the carrier and marker oscillators can be checked, and this accommodates crystals (not provided) in the range 0·2-15 Mc/s.

Three continuously adjustable sweeps are available: ±7·5 Mc/s, ±0·75 Mc/s and ±125 kc/s, with 50 c/s, 50 c/s and 400 c/s modulation, respectively. In each case there is ample voltage for horizontal deflection on the c.r.o.

The r.f. output voltage can be internally amplitude or frequency modulated and is arranged to cover a variety of possibilities; for example, the marker oscillator can be amplitude modulated internally or the carrier frequency modulated up to 10 Mc/s.

Both main dials are individually calibrated. The instrument is housed in a robust steel case finished in grey hammered enamel and measuring 17½in long × 13½in high × 9½in wide. It weighs 38 lb and is fitted with a carrying handle. The generator operates from 110-245 V a.c. mains.



Amplifier and photo-cell head of the L.R.I. light-actuated relay

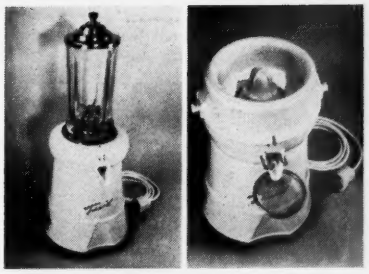
Light Actuated Relays

Photo electric type light-actuated relays designed with boiler protection requirements such as switching to safety on flame failure in mines have been produced by COMMUNICATION ELECTRONICS, LTD., Stanley Green Road, Poole, Dorset.

The equipment consists of a photo-cell amplifier including a mains transformer, valve, relays, etc.; and a photo-cell head incorporating a sighting tube and a B.V.A. photo-cell particularly sensitive to incandescent light sources. A glass window between the sighting tube and the photo-cell can be withdrawn and cleaned even with the unit operating, a considerable advantage in boiler applications.

All-Purpose Mixer

The new "Turmix 450" mixer and kitchen companion, available from A. E. WARNER (LONDON), LTD., 56, Brewer Street, London, W.1, consists of a standard base, housing a ½ h.p. motor, and four interchangeable attachments making it suitable for use as a liquidizer, pulverizer and cocktail mixer; fruit and vegetable juice extractor; vegetable shredder; and as a lemon squeezer. An automatic governor gear is fitted to the motor, giving speeds of 3,000, 8,000 or 12,000 r.p.m. according to the particular attachment being used.



The "Turmix 450" mixer shown as a liquidizer and cocktail mixer and (right) as a lemon squeezer

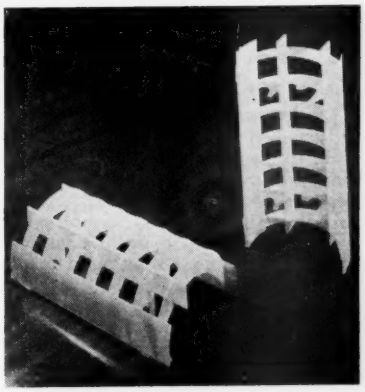
In the juice extractor a new patented metal is used, which, claim the makers, ensures that there is no loss of vitamin C during the process. The shredder, which holds ample quantities for a family, produces fine or coarse shred, depending on the type of plate fitted.

As a mixer only the price is £32 10s plus £14 11s purchase tax in the United Kingdom. Individual prices of attachments are:—Orange and lemon squeezer, £3 10s plus £1 11s 3d; juice extractor, £5 10s plus £2 8s; vegetable shredder, £7 10s plus £3 7s 3d.

Fluorescent Diffusers

The new clip-on type diffusers for bare fluorescent tubes announced by SIEMENS ELECTRIC LAMPS & SUPPLIES, LTD., 38-39, Upper Thames Street, London, E.C.4, are of translucent polystyrene, thus ensuring diffusion with a minimum decrease in illumination efficiency.

Each section has an overall length of 8in and unbroken continuity is obtained by means of a mortice and tenon assembly. The fittings are suitable for any 1½in diameter fluorescent tube and are fixed by push-fit action over the lamp. Packs of seven sections for all 5ft tubes are available at £1 7s, plus 6s 1d purchase tax; similar boxes of six sections for all 4ft tubes cost £1 3s, plus 5s 2d tax.



Two sections of the Siemens clip-on fluorescent diffuser fittings

Financial Section

STOCKS and SHARES

PERSISTENT firmness of prices in the industrial markets of the Stock Exchange suggests that investment confidence is on the way to recovery from the effects of the autumn relapse. Most quotations remain well below the peaks recorded about the middle of the year, but have gone some way, during the past week or two, towards reducing the deficit. A prominent part in the revival has been played by electrical engineering shares, especially those with nuclear power connections. A.E.I., Babcocks and English Electrics secured further gains; G.E.C. were called 63s 9d in the market. Parsons and Reyrolle moved up again respectively to the 81s 3d and £5 marks. Other improvements worth mention include more rises in Ericssons, Plessey and Murex. There are advances in Automatic Telephone, British Aluminium, Thornycroft and Wolf Electric. The radio section is good as a whole.

T.V. Sales

Interests of the makers of radio and television sets tend these days to cover so wide a field of electronics and electrical engineering that conditions in the radio industry itself have less influence than they used to exert upon the investments concerned. All the same, a considerable impression was made in this section of the market by the remarkable figures given in connection with the sale of sets during October. Even allowing for the effect of the pre-Budget rush of buyers, the total of 282,000 television sets and 123,000 radio sets sold in that month, caused surprise and an all-round rise in share prices. It is recognized that business during the next month or two may bring down the average nearer to normal. In the further future, on the other hand, the introduction of commercial television programmes to the Midlands and the North during 1956 is expected to sustain the demand.

Shares and Yields

In the radio market, investors are consistently willing to accept from Pye 5s deferred shares a yield well below the industrial market average. Allotment letters go out to-day (Friday) in connection with a "rights" issue of new "A" shares at 12s 6d. These are likely to be quoted at around 20s in early dealings, giving a prospective yield in the neighbourhood of 3 per cent from this year's rate of dividend. Thorn Electric 5s shares, with a dividend covered 5½ times by the latest earnings, also give the sort of yield (3½ per cent) associated with big "growth" prospects. On Ekco and Ultra 5s shares the current yield is between 4 and 4½ per cent. E.M.I. and Murphy shares show returns of between 5½ and 5¾ per cent, while on Cossors the yield exceeds 7½ per cent.

Decca Prospects

Decca 4s shares rose further to 43s 3d in advance of the announcement

The Week's Price Changes

Company or Board	Nom. Value	Middle price 5th Dec.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1955 Highest	1955 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	80½		3	3	3 14 6	94¾	76½
Brit. Elec. 1974/77	100	79½		3	3	3 15 6	93⅛	75½
Brit. Elec. 1976/79	100	83½		3½	3½	4 3 9	98¾	80½
Brit. Elec. 1974/79	100	95½		4¼	4¼	4 9 0	109	90½
Overseas Electric Supply								
Calcutta Elec.	£1	20/9		6†	6†	5 15 9	22/6	20/9
East African Power	£1	21/3		7	7	6 11 9	24/6	19/9
Nigerian Elec.	£1	21/6		10	10	9 6 0	27/-	21/-
Palestine Elec. "A"	£1	21/-		Nil	Nil	Nil	22/9	21/-
Perak Hydro-Elec.	£1	18/-		10	10	—	22/3	17/9
Equipment and Manufacturing								
Aberdare Cables	5/-	13/-	+6d	12½	17½	—	14/6	11/-
Aerialite	1/-	6/9	+9d	88½	45*	6 17 6	6/9	5/3
Allen, W. H.	£1	74/6		20	20	5 7 6	83/9	74/6
Aron Elec. Ord.	£1	55/6		15	15	5 8 0	63/9	55/6
Assoc. Elec. Ord.	£1	82/6	+3/-	11½	14	3 8 0	96/-	62/6
Automatic Tel. & El.	£1	63/9	+2/6	15	15*	4 14 0	79/6	60/-
Babcock & Wilcox	£1	78/9	+1/-	12*	15	3 16 3	98/-	68/6
Baldwin, H.	2/-	5/3	+3d	20	20	7 12 6	5/6	4/4
Bakelite	10/-	33/-		12½	16	4 17 0	34/6	27/-
British Aluminium	£1	52/6	+3/9	10	12	4 11 6	58/-	35/3
B.I. Callender's	£1	50/-	+1/6	10	12½‡	5 0 0	55/3	44/9
B.I. Callander's 6% Pref.	£1	23/-x.d.		6	6	5 4 3	26/6	21/9
British Thermostat	5/-	31/3		27½	27½	4 8 0	35/-	22/6
British Vac. Cleaner	5/-	8/3		25	30	—	10/-	6/6
Brook Motors	10/-	45/6x.d.		20	25	5 10 0	47/-	39/9
Brush Ord.	5/-	7/6		6	10	6 13 3	9/6	7/6
Bulgin, A. F.	1/-	7/-		30	45	6 8 6	8/-	4/-
Burco Dean	5/-	12/6	−6d	—	—	—	17/3	12/-
Chloride El. Storage	£1	67/6	+1/3	12½	17½	5 4 6	77/6	58/6
Clarke Chapman	£1	95/-		20	20*	4 4 3	102/6	68/9
Cole, E. K.	5/-	21/-	+9d	27½	17½*	4 3 3	25/6	18/3
Cossor, A. C.	5/-	9/9	+9d	10	15	7 13 9	14/-	8/9
Crabtree	10/-	28/6		20	20	7 0 3	34/6	27/6
Crompton Parkinson Ord.	5/-	15/-		20	16*	5 6 8	19/9	15/-
De La Rue	5/-	20/3	+3d	20	30	7 8 3	26/-	17/-
Decca	4/-	43/3	+2/-	35	56¼*	—	48/9	31/-
Desoutter	5/-	31/3		20	25	4 0 0	35/-	25/6
Dewhurst	2/-	11/-x.d.		24	30	5 9 0	11/3	7/3
Dictograph Tel.	2/-	7/3		20	20	5 10 3	9/3	6/6
Dubilier Condenser	1/-	4/6		25	25*	5 11 0	5/7	3/1
E.M.I.	10/-	29/3	+3/6	10	15	5 2 7	37/-	25/3
Electrical Components	5/-	15/-		20	25	8 6 8	21/3	13/9
Elec. Construction	£1	29/9	+1/-	15	8¾*	5 14 3	41/3	28/9
Enfield Cable Ord.	£1	19/-		Nil	Nil	Nil	25/3	18/6
English Electric	£1	65/-	+2/6	10	12½	3 17 0	86/9	54/3
English Electric 3¾% Pref.	£1	14/6		3¾	3¾	5 3 6	16/9	14/-
Ericsson Tel.	5/-	43/9	+1/3	25†	25*†	2 17 3†	46/6	29/-
Ever Ready	5/-	32/6	−6d	40	35*	5 7 9	38/-	22/3
Falk Stadelmann	£1	46/3		15	17½	7 11 3	52/6	42/-
G.E.C. Ord.	£1	62/6		12½	14	4 9 6	80/3	51/3
G.E.C. 6½% Pref.	£1	23/9x.d.		6½	6½	5 9 6	28/4	23/6
General Cables	5/-	16/9	+6d	30	30	8 19 0	17/-	15/-
Greenwood & Batley	£1	45/-	−2/6	17½	17½	7 15 6	57/6	45/-
Hackbridge Cable	5/-	23/3	+6d	20	25	—	23/3	14/-
Hackbridge & Hewittic	5/-	20/-		25	30	—	24/9	17/-
Hall Tel. Acc.	10/-	31/6		10	10	3 3 6	32/-	11/-
Heatrae	2/-	5/-		12½	15	6 0 0	5/9	4/3
Henley's	10/-	16/9		10½	10½	6 5 6	21/3	15/9
Holophane	5/-	18/9		25	30	—	19/9	16/-

* After scrip issue. † Free of income tax. ‡ Dividend forecast.

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.

of the results in respect of the year ended last March. Good figures are already fairly well assured; the last annual meeting was not held until all but a few weeks of the 1954–55 period had been completed, and the chairman was then in a position to speak of another very successful year's trading. As regards dividends, the two interims paid this year have been maintained at the same rate as before, but each has been accompanied by a warning that, in view of the capital increases, stockholders should not assume that the year's total will also come to the same amount per share. Last time the final dividend, of 1s 8d per share, making a total of 2s 3d, was declared on 16th December.

in Electrical Investments

Company or Board	Nom. Value	Middle price 5th Dec.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1955 Highest	1955 Lowest
Equipment and Manufacturing—continued						£ s d		
Hoover	5/-	39/6	+6d	45	70	8 18 0	52/6	35/6
I.C.I.	£1	48/-	+1/6	15	10*	4 3 3	61/9	38/3
Intl. Combustion	5/-	18/-		20	25	—	24/6	16/-
Johnson & Phillips	£1	44/-	+9d	15	15	6 16 6	52/6	39/6
Lancashire Dynamo	£1	44/6		14	15	—	56/5	37/3
Laurence, Scott	5/-	16/3		20	12½*	3 17 0	19/6	14/6
Lister, R. A.	£1	30/-	+1/3	12	9·3*	6 4 0	40/-	28/9
London Elec. Wire	£1	50/9		10	12½	4 18 6	61/3	50/6
Lucas, J.	£1	40/-		7½	7½	3 15 0	56/6	38/9
Marryat & Scott	2/-	10/3		25	30	5 17 0	13/-	9/6
Mather & Platt	£1	60/6	−3d	15	13·4*	—	75/-	48/-
Metal Industries	£1	25/-		9	9	7 4 0	38/-	25/-
Midland Elec. Mfg.	£1	50/-		15	10*	4 0 0	55/-	44/-
Morphy-Richards	4/-	27/9		35	50	7 4 3	35/-	27/-
Murex	£1	69/6	+3/9	15	20	5 15 1	67/6	49/3
Newman Ind.	2/-	2/9		10	10	7 5 6	3/6	2/4
Oldham & Son	1/-	3/-x.d.		17½	20	—	3/6	2/1
Parnall (Yate)	5/-	8/3	−3d	8	14	8 9 9	13/2	7/3
Parsons, C. A.	£1	81/3	+3/9	7½	10	2 9 1	100/-	56/-
Plessey	10/-	81/3	+5/-	20	27½	3 8 0	89/-	55/-
Pye Deferred	5/-	22/3	+1/-	20	12½*	—	32/9	14/3
Revo	10/-	12/6	−6d	9	9	7 4 0	15/6	12/6
Reyrolle	£1	£5	+5/-	13⅓	15	3 0 0	127/6	89/-
Rheostatic	4/-	12/3		20	22½	—	14/3	9/3
Richardsons Westgarth	5/-	16/-		15	16⅔	5 4 3	19/-	11/-
Scottish Cables	4/-	16/9		27½	27½	6 11 3	22/6	16/3
Smith (England), S.	4/-	14/6		17½	17½	4 16 6	20/-	14/9
Southern Areas	£1	30/6		7½	10	6 11 3	38/-	27/6
Strand Elec.	5/-	8/3	−6d	17½	15*	8 11 6	13/3	7/6
Sturtevant	5/-	29/6		18·9	14·4*†	2 8 6†	35/9	21/-
Sun Elec.	£1	35/-x.d.		15	20	—	35/-	33/9
Switchgear & Cowans	5/-	16/9	+6d	10	20	5 19 6	17/-	11/-
Taylor Tunnicliff	5/-	13/9		12½	15	5 9 0	16/3	11/3
T.C.C.	10/-	43/9		30	25*	5 14 3	53/9	41/-
T.C. & M.	£1	31/-	+1/-	8½	8½	5 9 9	40/9	29/3
Telephone Mfg.	5/-	8/3		10	10	6 1 3	11/6	7/9
Thorn Elec.	5/-	21/9	+6d	20	15*	3 9 0	33/-	13/9
Thornycroft	£1	47/6	+2/6	15	15*	6 6 3	47/6	34/6
Tube Investments	£1	60/-	+2/6	22½	14*‡	4 13 3	60/-	55/-
Vactric	5/-	16/3		10	15*	4 12 3	22/-	12/-
Veritys	5/-	8/-	−1/9	12½	12½	7 16 3	12/2	7/-
Walsall Conduits	4/-	13/9	−3d	70	70	—	17/3	12/-
Ward & Goldstone	5/-	36/3x.d.	+6d	50	30*	4 2 9	45/-	32/6
Watford	2/-	7/-		22½	25	—	8/9	6/3
Westinghouse Brake	£1	90/-	+3/9	16	18	4 0 0	110/-	82/-
West, Allen	5/-	13/-		17½	15*	5 15 6	16/6	8/-
Wolf Electric	5/-	23/9	+1/9	17½	20	4 2 6	23/9	16/1
Trusts, Transport and Communications								
Anglo-Am. Tel.:								
A. Ord.	100	72½		6	6	8 5 6	88	67½
Ord.	100	45		3¾	3¾	8 6 8	54½	45
Anglo-Portuguese	£1	22/-	+1/-	8	8	7 5 6	27/-	21/-
Brit. Elec. Traction:								
Def. Ord.	5/-	19/6	+6d	50	22½*	5 14 0	24/3	19/-
Cable & Wireless:								
Ord.	£1	43/-	+6d	9	10	4 13 0	54/-	39/6
4% Loan	100	92½x.d.		4	4	4 6 6	100	92
Calcutta Trams	£1	26/9		6†	7½†	5 12 3†	26/9	20/-
Cape Elec. Trams	£1	18/9		5½	7½	8 0 0	19/6	16/6
Marconi Marine	£1	31/3		10	10	6 8 0	41/3	31/3
Oriental Tel. Ord.	1/-	79/6		16	—	—	102/6	72/6
Telephone Rentals	5/-	11/3		10	12½	5 11 0	13/6	9/6

Electrical Apparatus Co.

The chairman of the Electrical Apparatus Co. will have had another year of good progress under review at the annual meeting which was due to be held on Tuesday of this week. Net profits in the twelve months ended in July improved by more than a quarter to £164,000. This represented earnings of practically 100 per cent gross on the ordinary capital of £281,000, and therefore provided substantial cover for the 22½ per cent dividend. The latter remained at the same rate as before, but went to capital increased by a one-for-eight scrip issue. Dealing with prospects, the report last month described the order book as in excellent shape and referred to an increasing demand for the equipment. At about 20s the 5s shares show a yield of rather more than 5½ per cent.

Westinghouse

Westinghouse Brake & Signal closed their annual accounts at the end of September, and if last year's precedent is followed, the results will be known in the week before Christmas. Last time, an expansion of more than 50 per cent in the net surplus enabled the company to raise the dividend from 16 to 18 per cent. Earnings represented 63 per cent on the ordinary capital. Shareholders were given a guide to the coming results in August, when powers were taken to increase the authorized amount of borrowing and ordinary capital. They were told then that the order books of the group had increased rapidly and were expected to go on growing. Subsequently the company purchased the greater part of the capital of Douglas (Kingswood), Ltd. On last year's dividend, the yield from the shares at 90s is 4 per cent.

Company News

Revo Electric 10s shares eased off to 12s 6d following the statement accompanying the declaration of a 3½ per cent interim dividend, the same as that for last year. Profits for the six months to the end of September are reported to show a small reduction, but the winter half of the year is usually the period of the chief activity, and the outlook is described as not unsatisfactory.

Peto Scott Electrical Investments 1s shares were dealt in up to 3s on news of the company's re-entry into the dividend list with a distribution of 16⅔ per cent out of a net profit of £61,000. The payment goes to £30,000 ordinary capital resulting from this year's organization. The £30,000 further capital issued subsequently will rank for future distributions.

REPORTS and DIVIDENDS

Brook Motors, Ltd.—The trading profit for the year to 30th September last is £671,938, as compared with £595,594 for the preceding year, and after deducting a trading loss of subsidiary of £38,734, and adding income from other sources, the total is £645,689. After meeting all charges, including £272,247 for taxation, there is a net balance of £231,446 (against £178,495), to which is added £449,615 brought in, and over-provision for taxation of £81,655, making £762,716 available. As already announced, the final ordinary dividend is 20 per cent, making 25 per cent for the year. For the previous year an interim dividend of 5 per cent was paid on 998,683 shares, and a final dividend of 15 per cent on 1,141,364 shares. The balance carried forward is £674,657.

In his statement which accompanies the report and accounts, Mr. F. V. Brook (chairman) says that in the year under review they achieved a record turnover. During the year they introduced an increased range of industrial motors developing up to 600 h.p. In addition to the home market demand, a number have been supplied to overseas markets, including repeat orders from the United States. They are also entering the field of small shaded pole motors, where demands are large for fan ventilation, heating appliances, light instrument and laboratory equipment. Designs are completed and production has commenced.

Referring to sales in America, Mr. Brook says that the minor depression has entirely disappeared during the last six months, resulting in the Brook Motor Corporation sharing in the trade boom which is now taking place. A great proportion of the motor stocks there during the first twelve to eighteen months of the company's existence have been sold and large replacement orders are being received and shipped. The larger h.p. motors are becoming particularly popular, not only through quality, but because of the improved delivery dates they can make against American competitors. These motors are not only going to the United States, but to both Mexico and Cuba.

Further premises have been acquired, part of which will be used for the repair of equipment both of their own and competitive manufacture. A 28-acre site is being negotiated near Huddersfield where it is intended firstly to build a factory for their fractional h.p. motor development.

Turner & Newall, Ltd., report group profits for the year to 30th September last of £12,991,892, as compared with £12,044,351 for the preceding year, and after providing £6,740,938 for taxation, the net profit is £5,753,879 (against £5,300,680). Stock and replacement reserves received £1,500,000 and general reserve £2,400,000. It is proposed to pay a final ordinary dividend of 20 per cent (against 17½ per cent), making 25 per cent for the year (22½ per cent). The balance carried forward is £2,166,243 (against £2,024,295 brought in).

Peto Scott Electrical Instruments, Ltd.—The net profit for the year to 30th June last, after meeting all charges, including £6,500 for taxation, is £61,176, and compares with a loss of £30,882 for the previous year. Dividends are resumed with a recommendation of 16⅔ per cent for the year. The previous payment was for 1951-52, when a dividend of 12½ per cent was paid.

Aberdare Cables, Africa, Ltd.—After providing for Union and Provincial taxes of £10,508, the consolidated net profit for the year to 30th June last is £52,042, as compared with £66,206 for the preceding year. General reserve receives £25,155, and the dividend for the year is maintained at 15 per cent. The balance carried forward is £60,203 (against £83,647 brought in).

Richardsons, Westgarth & Co., Ltd., are to hold an extraordinary meeting on 14th December to consider proposals for increasing the capital by £2,000,000 by the creation of 8,000,000 new shares of 5s each. It is stated that the company has no plans for issuing any further capital, but in order to obtain the maximum relief from capital duty on the increases in the issued capitals of the operating companies, it is necessary also to increase the authorized capital of the parent company.

Parkinson & Cowan, Ltd.—In announcing the payment of the half-year's cumulative preference dividend the board states that this should not be taken to indicate that the trading results of the group have been satisfactory during 1955. The board refers to the chairman's statement to stockholders at the annual general meeting in May last, in which he referred to the Government plan to restrict home sales by tightening control over hire purchase, and said that it was too early then to assess the effect on the company's gas appliance business, which normally provides at least a third of the group turnover. The directors state that there has been a serious fall in the demand for these appliances, particularly those of high quality. Although other divisions in the group are trading normally, the interests of ordinary stockholders will be adversely affected for the time being.

The Plessey Co., Ltd.—In his statement circulated to shareholders with the report and accounts for the year to 30th June last, Mr. A. G. Clark (chairman and managing director) says that the research and development work in recent years is bringing its reward to-day. As a result the range of activities continues to widen, and expansion is proceeding even more rapidly than they dared to anticipate that it would. In consequence the additional capital raised rather under two years ago has already become fully employed, and the need for more is becoming apparent. The question is still under consideration, and it is the subject of discussions with their advisers. Shareholders will be informed of proposals when these discussions have been brought to a conclusion. The annual general meeting will be held on 29th December (not 30th December as previously announced).

The Revo Electric Co., Ltd., has declared an interim dividend of 3½ per cent (unchanged).

Belliss & Morcom, Ltd., have declared an interim dividend of 4 per cent (against 2½ per cent). The directors state that an increase in the year's total is unlikely.

Johnson, Matthey & Co., Ltd., are paying an unchanged interim dividend of 3 per cent.

Associated British Engineering, Ltd., is paying an interim ordinary dividend of 4 per cent.

Pye (Ireland), Ltd., is paying an interim dividend of 2 per cent (against 2½ per cent) on increased capital.

Increase of Capital

Lamp Caps, Ltd.—Increased by £150,000, in £1 shares, beyond the registered capital of £150,000.

Liquidations

Rothermel, Ltd., manufacturers of radio and electrical equipment.—Winding up voluntarily. Liquidator, Mr. E. D. Bard, 21, Copthall Avenue, London, E.C.2, appointed 10th November.

Adalco, Ltd., electric fire manufacturers.—Last day for receiving proofs for dividend 10th December. Liquidator, Mr. F. M. Collins, Inveresk House, 346, Strand, London, W.C.2.

Bankruptcies

D. L. Stoneham, 3, Crombey Street, Swindon, Wilts, electrical contractor, lately carrying on business at that address.—Receiving order made 23rd November on debtor's own petition. Public examination 11th January at the County Court Buildings, Clarence Street, Swindon.

W. J. K. Incledon, 38, Rimrose Drive, Huyton, Lancs, lately carrying on business at 203, West Derby Road, Liverpool, electrical engineer.—Trustee, Mr. S. O. Henry, 5, Rumford Place, Chapel Street, Liverpool, appointed 24th November.

D. A. Trotman, formerly carrying on business at Salter Street, Berkeley, Glos, as an electrical engineer.—First and final dividend of 3s 6¾d in the £, payable at the Official Receiver's office, 26, Baldwin Street, Bristol.

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